Tappi

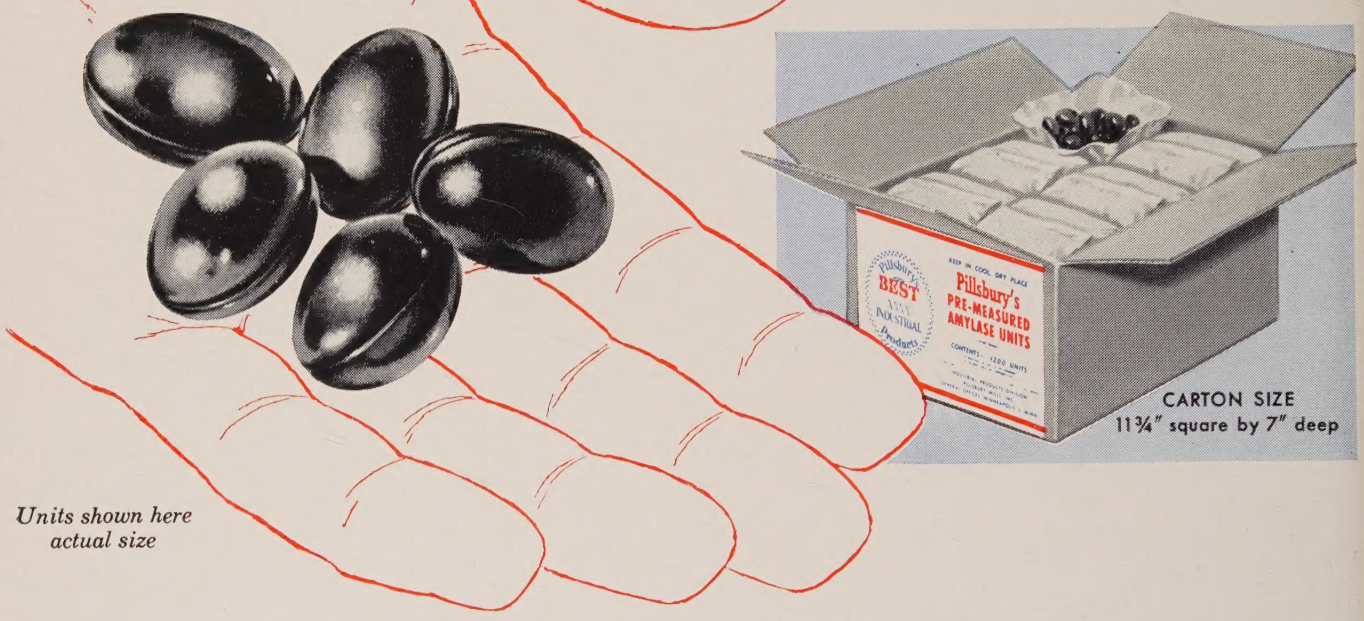
PUBLISHED BY THE TECHNICAL ASSOCIATION OF THE PULP AND PAPER INDUSTRY

OCTOBER 1949

Revolutionary New Enzyme Development for Coating and Tub Sizing!

Pillsbury's PRE-MEASURED AMYLASE UNITS

PAT. PENDING



Units shown here actual size

For the First Time... Enzyme Charges in Soluble Capsules

In the preparation of coatings and tub sizings from starch, the new Pillsbury's Pre-Measured Amylase Units offer you—

Simplicity—No more weighing or measuring of enzymes. *Just count* the small number of units required and toss them into the slurry.

Efficiency—Fully protected right up to the moment they are used, these standardized enzyme charges are released at the correct point for greater efficiency.

Economy—Total cost of converting is brought down to very few cents per 100 pounds of starch in the average mill. Measuring and handling losses are eliminated, too.

Accuracy—No more errors in weighing and measuring enzymes. These stable enzyme units retain their potency indefinitely with ordinary care.

Superiority—The enzyme in Pillsbury's Pre-Measured Amylase Units has been selected because of its superior starch-converting properties. It assures end products of maximum adhesiveness and with minimum of specks.

Convenience—Easy to use and store. These units come packed in small cartons, 11¾" square and 7" deep. This compact size permits speedy parcel post delivery, minimum storage space, and enables your plant to operate on smaller inventories.

Write for Full Information—Pillsbury's technical service offers you the experience and technical know-how of men seasoned in the application of enzymes in industry. They are at your service and will cooperate with your organization in running trials without obligation.

Pillsbury's BEST XXXX INDUSTRIAL Products

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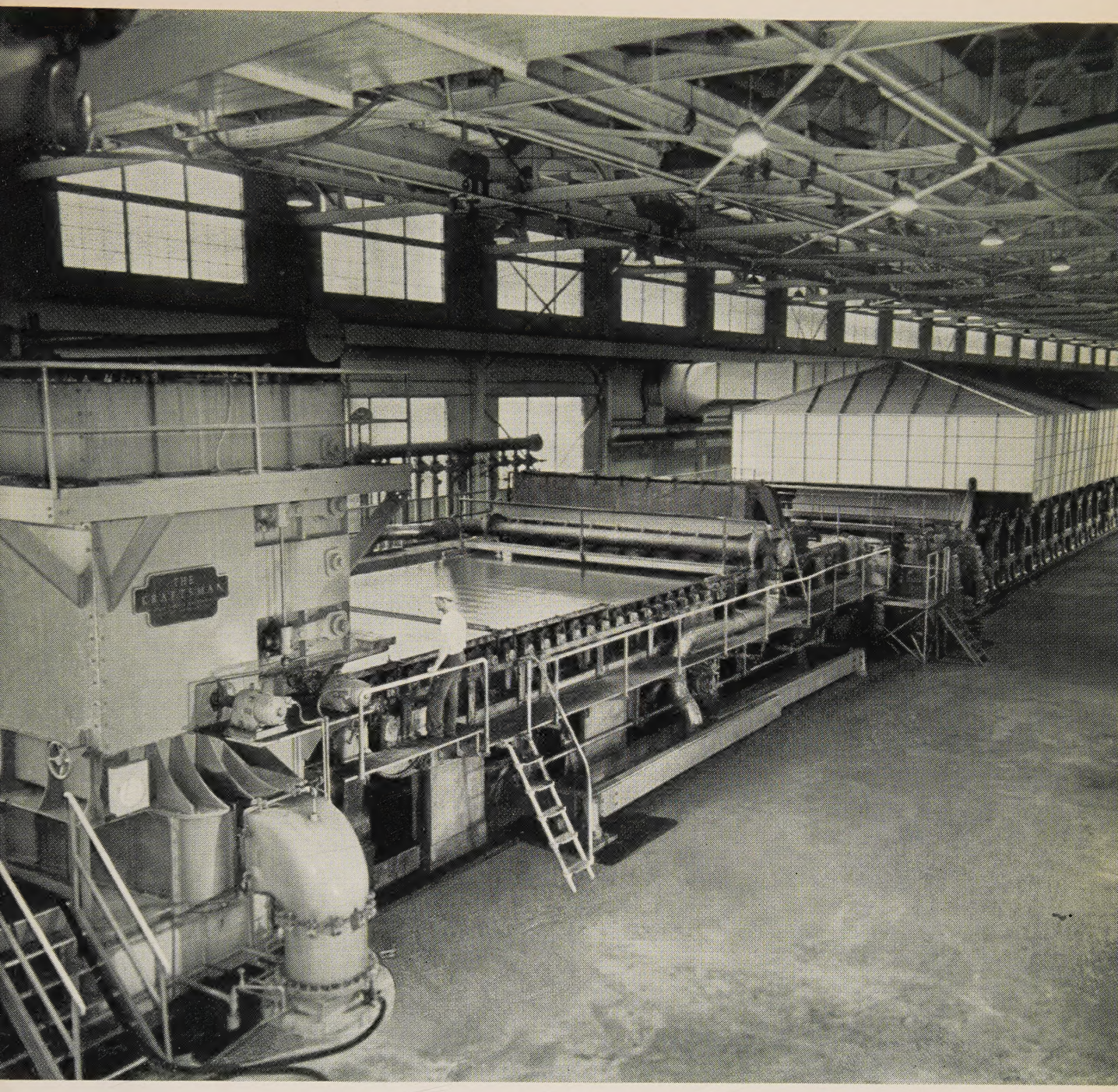
PILLSBURY MILLS, INC., INDUSTRIAL PRODUCTS DIVISION, MINNEAPOLIS, MINNESOTA

North Carolina: kraft container and specialties



A long stride forward was taken by Kieckhefer Container Company's subsidiary, North Carolina Pulp Co., Plymouth, N. C., when in 1947 its huge expansion program climaxed in the start-up of "The Kraftsman"—216″ Beloit giant shown above. High speed and top quality production result from the combination of latest design improvements and paper-making skill. This year, a second phase of expansion was rounded out when the No. 2 machine was completely modernized by Beloit . . . builders of papermaking machinery since 1858.—*Beloit Iron Works, Beloit, Wisconsin.*

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Mathieson's **BALTIMORE** *bound . . .*

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In this new location, deep in the chemical heartland of America, we will continue to serve our customers quickly and efficiently.

Mathieson Chemical Corporation
MATHIESON BUILDING
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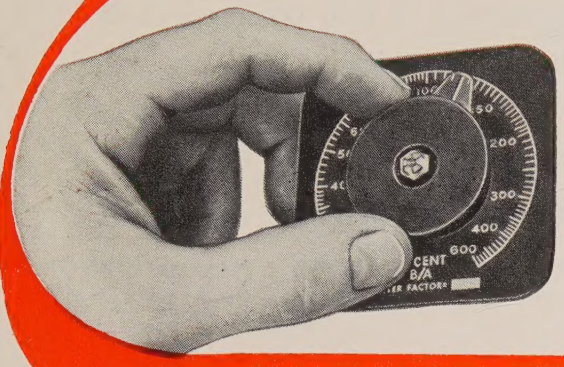
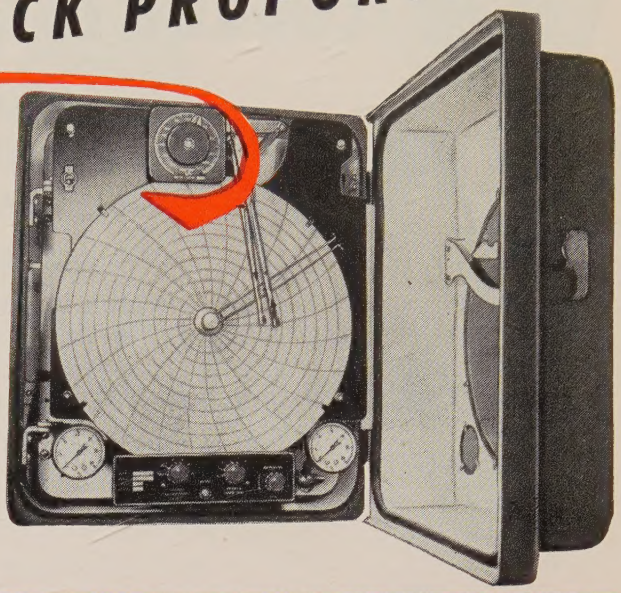
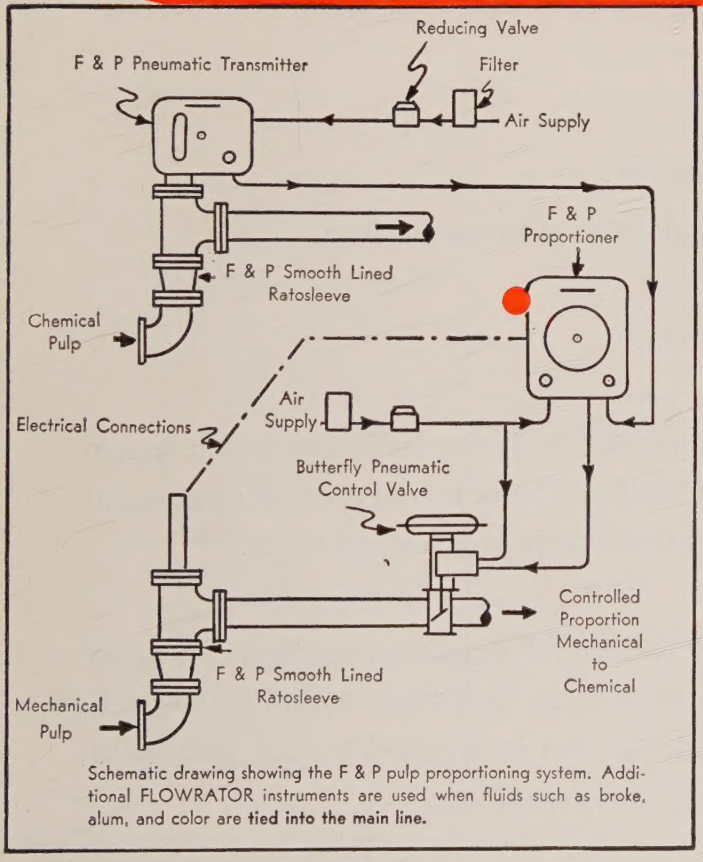
A TWIST OF THE WRIST CHANGES SLUSH STOCK PROPORTIONS





THE NEW F & P PULP PROPORTIONING SYSTEM



Schematic drawing showing the F & P pulp proportioning system. Additional FLOWRATOR instruments are used when fluids such as broke, alum, and color are **tied into the main line.**

- ***Eliminates Head Boxes***
- ***Eliminates Pulp Return Lines***
- ***Provides "Basis Weight" Control***
- ***Saves Floor Space***
- ***Records and Totalizes Pulp Flow***

Yes and more! The new F & P slush stock proportioning system . . . based upon the modern science of instrumentation . . . is rapidly replacing cumbersome and bulky compartment type feeders.

F & P INTEGRATED control systems start at the paper machine and, from the measurement of its speed, control pulp flow rate. Stock chest level . . . chemical to mechanical pulp ratio . . . size . . . color and filler flow rates are all "tuned" to exact proportion by a simple-

TWIST OF THE WRIST.

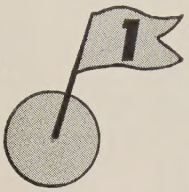
Write for technical bulletin "New Developments in Pulp and Paper Mill Instrumentation."

FISCHER & PORTER CO.
Dept. 9W-7P, Hatboro, Pa.

FLOWRATOR
TRADE MARK

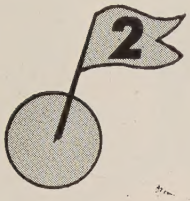
INSTRUMENTS FOR FLOW RATE MEASUREMENT AND AUTOMATIC FLOW CONTROL

5 MONEY SAVING ADVANTAGES of the CONKEY INTEGRAL EVAPORATOR



Erection time generally *one quarter* that required for other types.

Vapor body, heating element, entrainment separator and flash chamber constructed in one common shell which is set into place in one operation.

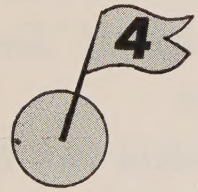


As much as 30% reduction in floor space.

No external entrainment separators and flash chambers.

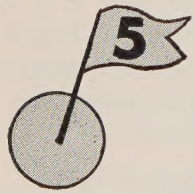
Negligible pressure drop.

Due to streamlining of design and integration of construction.



Increased evaporator capacity.

Due to great reduction of pressure drop.



Minimum maintenance.

Design has eliminated many flanged joints and a space exists between shell and outer row of tubes wide enough for a man to walk through and inspect tubes.

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Digestors	Filters	Kilns
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PROCESS EQUIPMENT DIVISION GENERAL AMERICAN TRADE MARK

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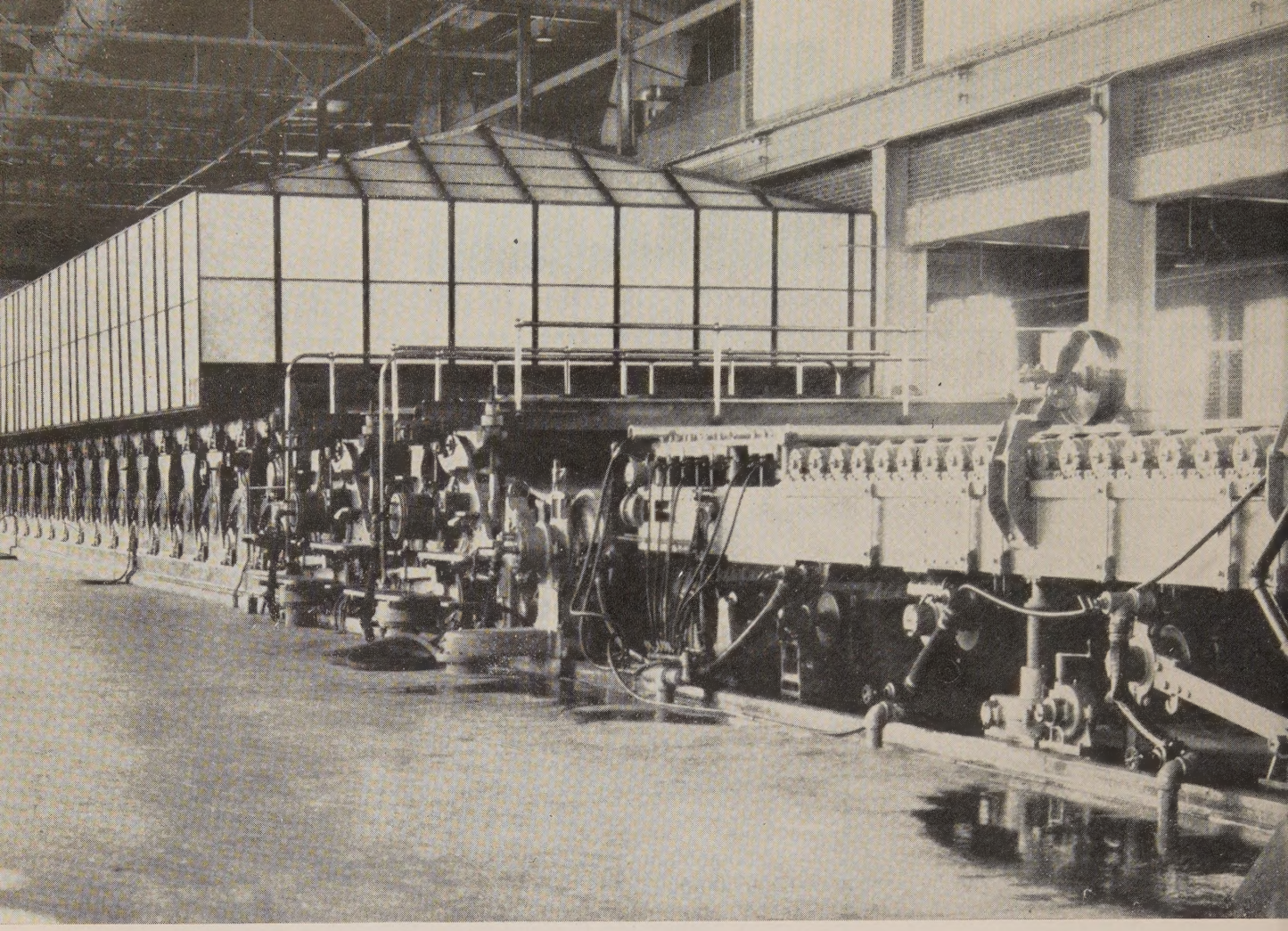

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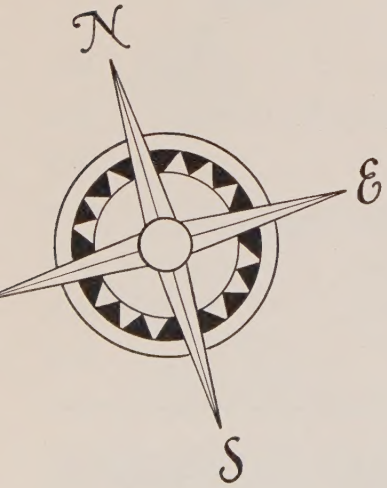

In France, England, Finland, South America, Africa, Canada, and every section of the United States, Bagley and Sewall Machines are making paper . . . every kind of paper from newsprint and board to the finest bond and tissue.

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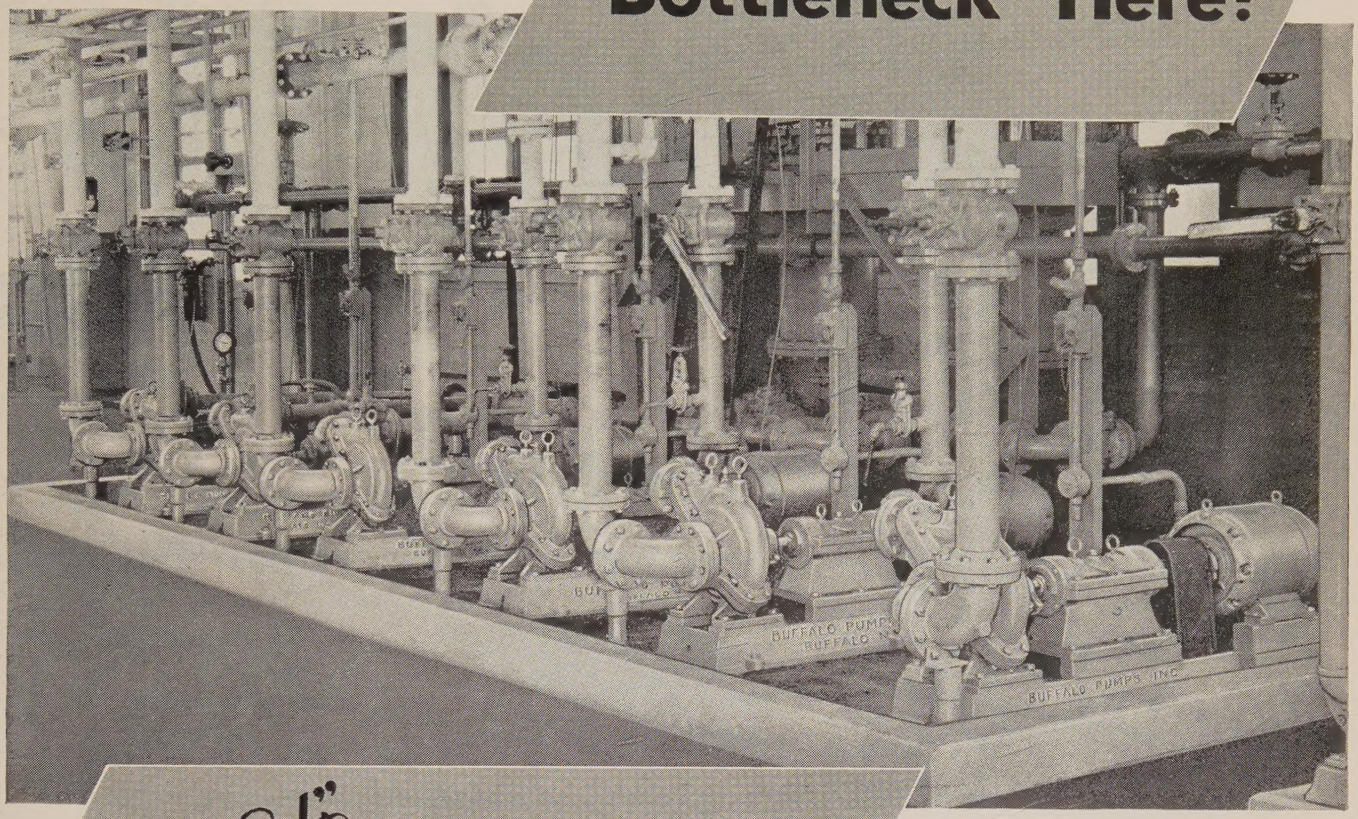
"Buffalo" Diagonally-Split Pumps like these are used in many prominent Paper mills



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● You don't need to worry about clogging—or any other kind of pump stoppage—with "Buffalo" Stock Pumps working for you!

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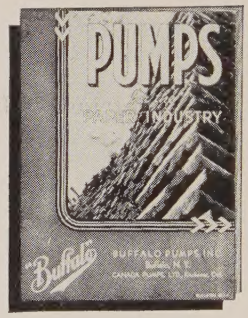

Why not write now for Bulletin 953-F, shown above, and get the facts on the complete line of "Buffalo" Pumps for every stock? THERE'S LITERALLY NOTHING FLIMSY ABOUT THESE PUMPS! And as users of "Buffalo" Pumps will tell you, this construction saves you money year after year on the job!

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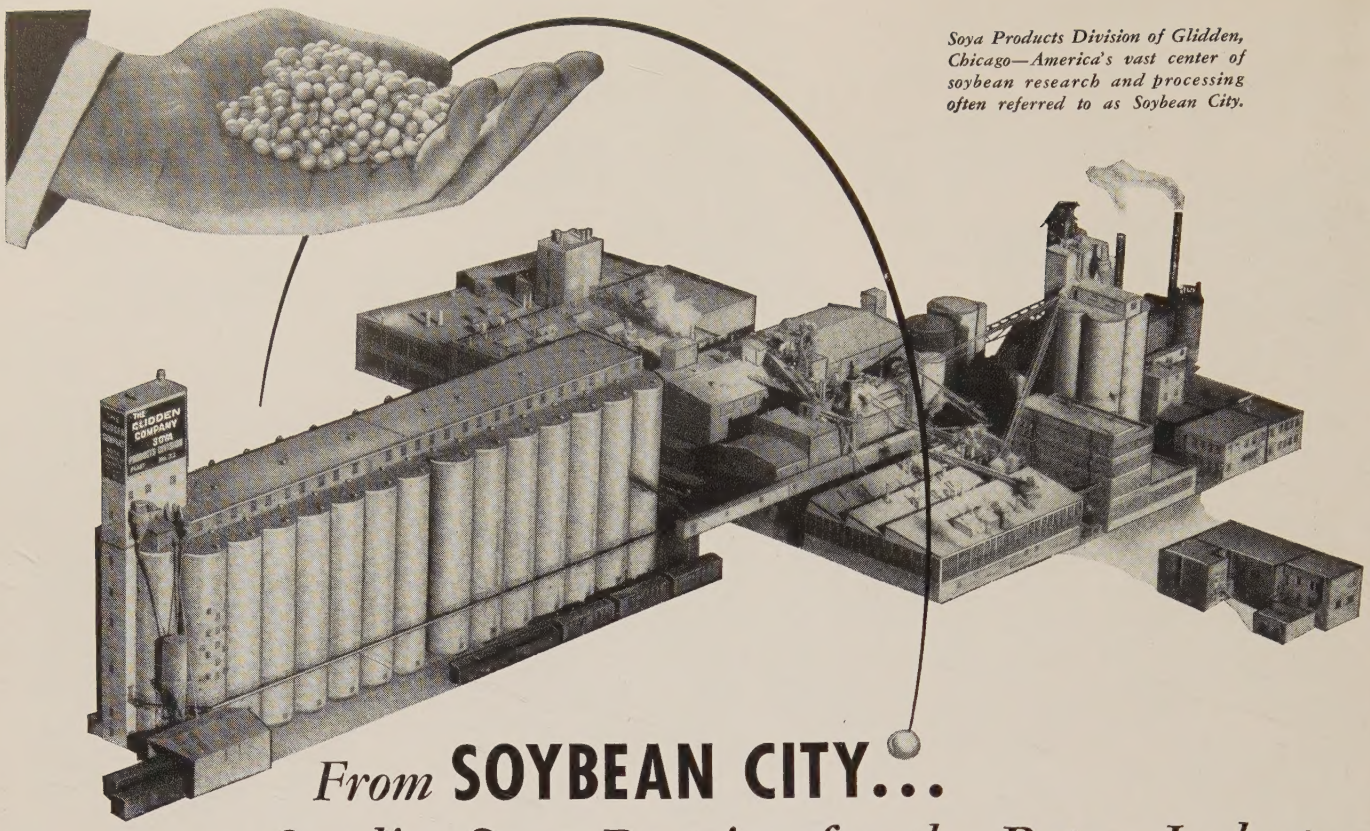

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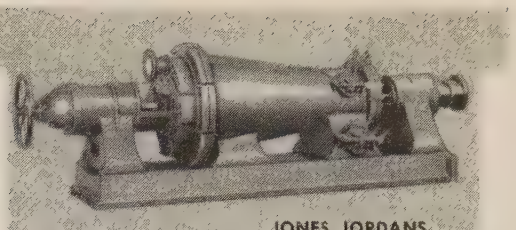

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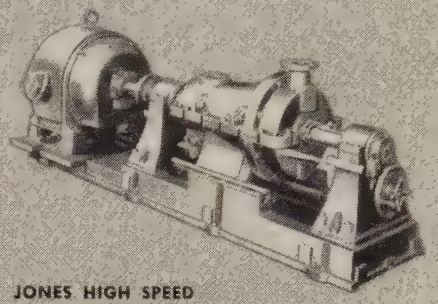

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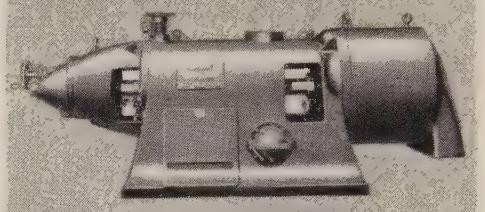


JONES COMPOSITES

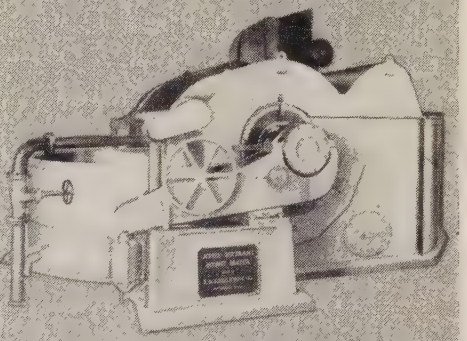
TAPPI CONVENTIONEERS!

Ask the Jones representatives at the Boston meeting for a list of mills in your locality where you can see Jones engineering at work.

E. D. JONES & SONS COMPANY

E.D. Jones PITTSFIELD, MASS.

BUILDERS OF QUALITY STOCK PREPARATION MACHINERY



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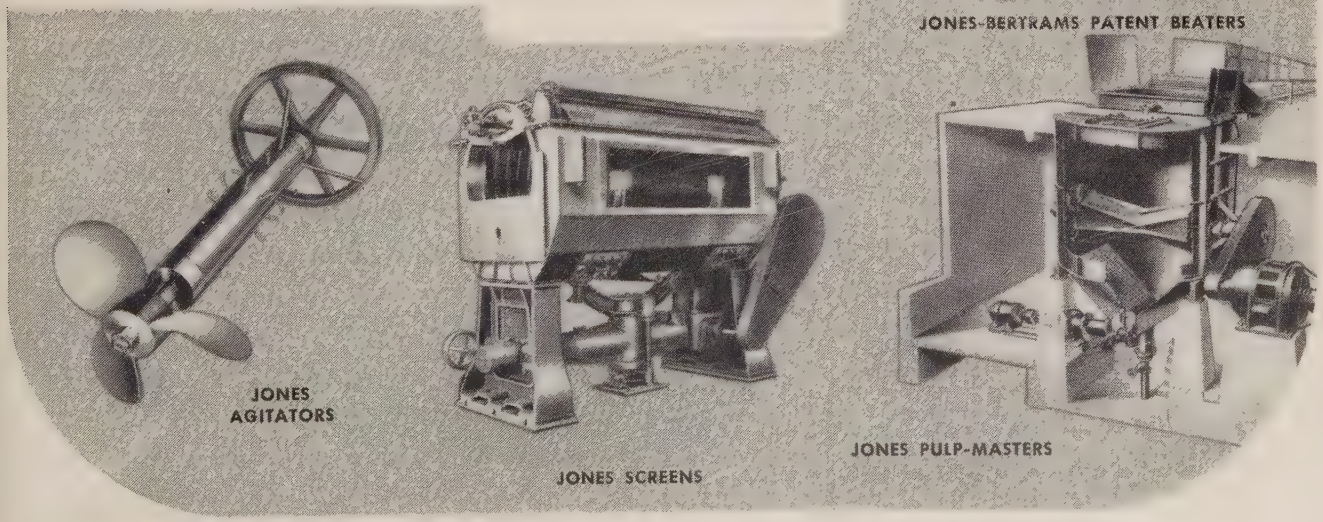

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JONES SCREENS

JONES PULP-MASTERS

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COATED PAPER

FLINTED PAPERS

BEATER DYEING

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full strength and lakes
Dispersible "Monastral"
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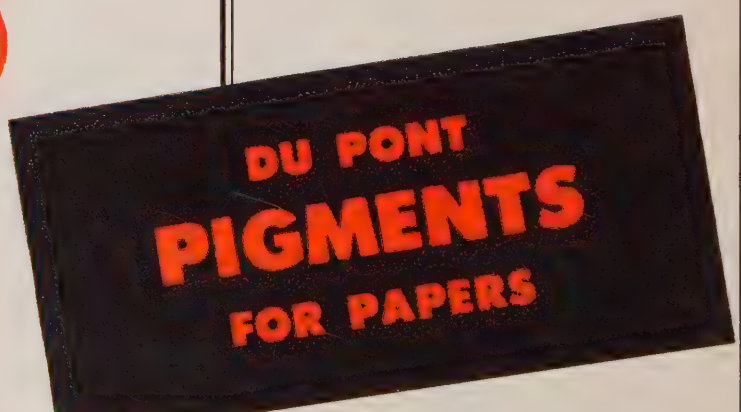
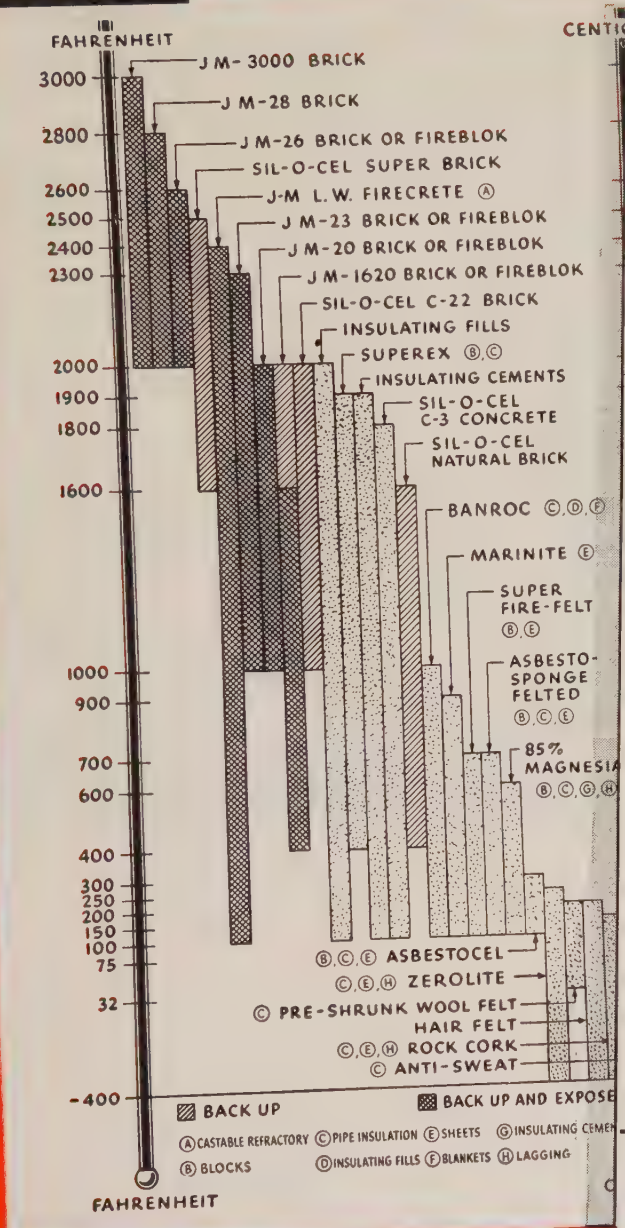
• Tune in to Du Pont "Cavalcade of America, Tuesday Nights—NBC coast to coast



Ready reference chart . . .

Johns-Manville THERMAL INSULATIONS



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Title_____

Company_____

Address_____

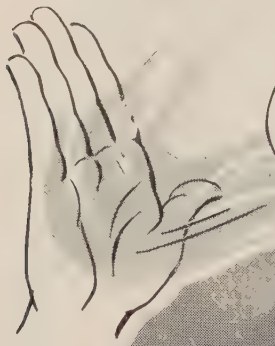
City_____ State_____

T-10

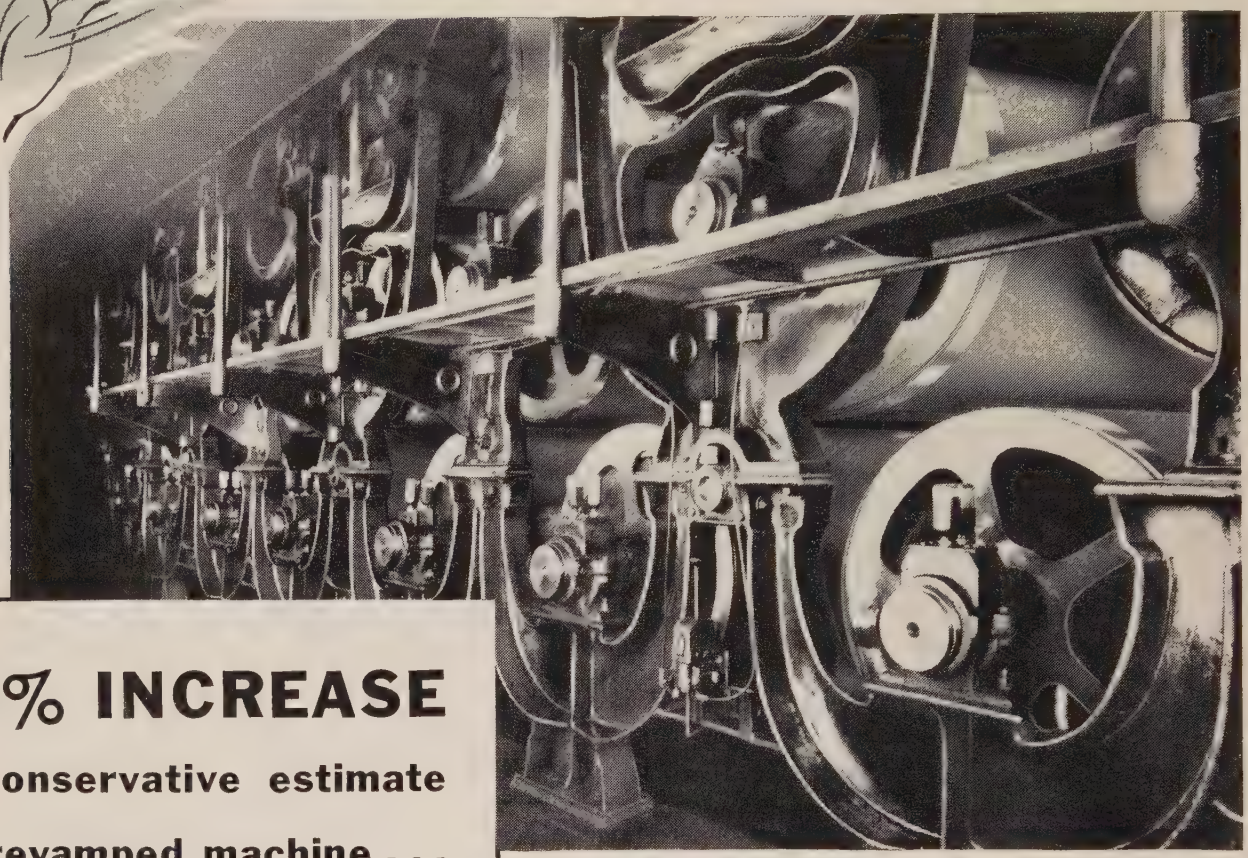
FOR EVERY TEMPERATURE JM EVERY

For further information write your nearest J-M office or Johns-Manville, 22

Helping speed up production of



Carey Fire-Chex Shingles



16% INCREASE

is conservative estimate on revamped machine . . .

24 Lukenweld Jacketed Steel Drier Rolls replaced rolls of another type of construction on the dry end of this 3-high felt machine at The Philip Carey Manufacturing Company, Lockland, Ohio.

New product of The Philip Carey Manufacturing Company, Fire-Chex Shingles are the first and only shingles, without an underlayment, to be awarded a Class A rating by Underwriters' Laboratories, Inc. Lukenweld Drier Rolls have an important part in the production of these shingles.

Replacement of 24 old-style rolls on a 3-high felt machine with Lukenweld Jacketed Steel Drier Rolls resulted in a substantial increase in production—conservatively estimated at 16%.

These properties help account for this increase; steam passages in Lukenweld Rolls are narrow, forcing high-speed circulation and scavenging. The jacketed steel plate construction permits thinner sections, causing heat to be transferred rapidly and uniformly. Lukenweld Jacketed Steel Drier Rolls can be safely operated at high steam pressures—up to 350 psi and higher.

If you want rolls to replace present equipment or complete new machines, we'll help select what you need, design and build the complete drier unit. Bulletin 358 tells you more about Lukenweld Jacketed Steel Drier Rolls; Bulletin 505 gives actual case histories on applications in various industries. For copies, write Lukenweld, Division of Lukens Steel Co., 501 Lukens Bldg., Coatesville, Pa.

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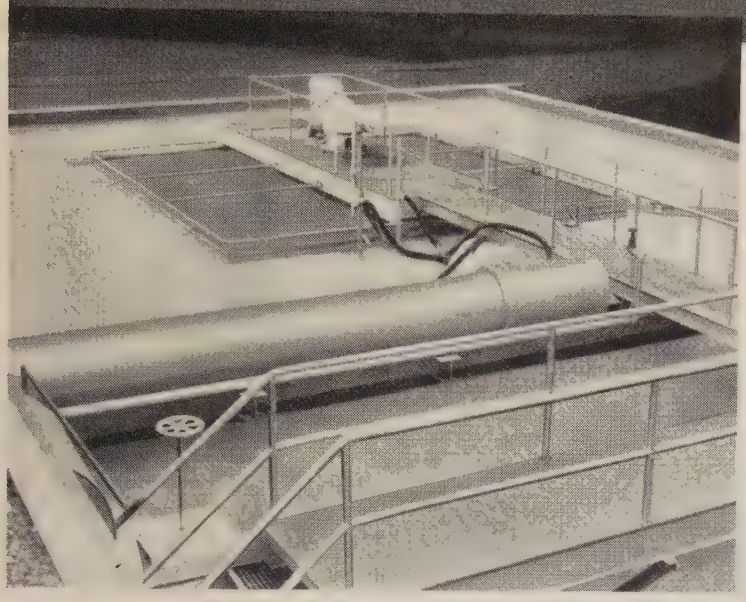

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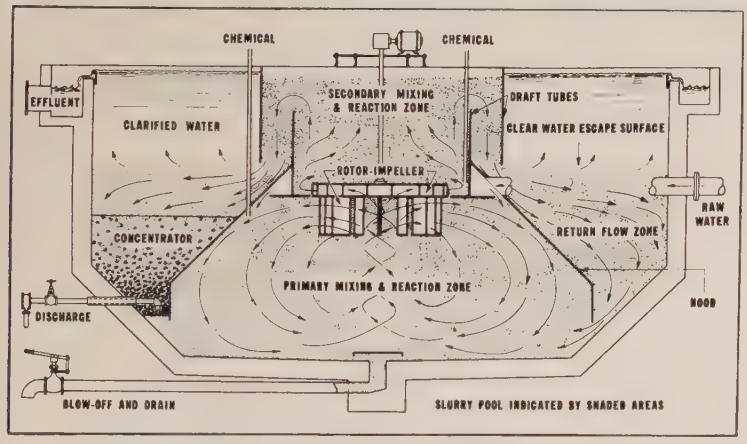

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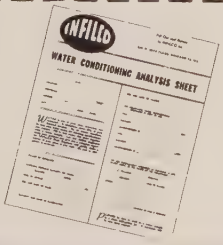

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The PRESIDENT'S PAGE

Albert E. Bachmann

A Cost Engineering Program for TAPPI

Dr. Holzer, Dr. Benson and Gentlemen: It is indeed a pleasure for me to be here today to bring to you the greetings of the officers and Executive Committee of TAPPI. We, from the East, are particularly happy to have the privilege of being here as your guests. Your welcome has been most cordial.

We regard your Pacific Coast Section as one of our strongest and most progressive sections. You have instituted many instructive and stimulating innovations in your meetings. Your fidelity to purpose has been a great source of inspiration to us despite our distance of separation.

The recent resolution of your section complimenting the efforts of those involved in the successful launching of the publication *Tappi* was very gracious. For your information, the largest share of the credit for the inspiration and development of the project is due George J. Brabender, W. F. Gilllespie, J. D'a Clark, Werner Kaufmann, and J. W. Hemphill, in about that order. The consummation of the project into the splendid finished job was largely the work of your Secretary, R. G. Macdonald. His infinite capacity for hard work and his rapid mastery of detail in the publishing field did much to produce the fine result you see today. The phase of administering its scientific integrity has been admirably handled by Dr. C. J. West and his editorial board.

On the President's page of the April issue of *Tappi*, I promised that your Executive Committee would attempt to provide the organizational structure and initial impetus to develop some new fields of activity in which more of our members could participate. We need very badly a greater participation of more of our members in the activities of our committees which are the Life Blood of TAPPI. In the July issue, I attempted to outline some of the needs for attempting to arrive at more concrete basic principles of Paper-making and some suggestions regarding the methods whereby we could move in this direction.

Today I want to discuss with you a very timely and important subject, which is termed Cost Engineering. Cost engineering emphasizes the engineering approach to standards, controls, and costs in general.

It certainly is no news by this time to anyone in our industry today that more rigorous and competitive times are back with us again. The comparative ease of essentially cost plus operation of the past several years is over. In his recent address at the occasion of the Twentieth Anniversary of the founding of the Paper Institute, Mr. Ernst Mahler, one of the founders and medalists of TAPPI and Executive Vice-President of Kimberly-Clark, aptly phrases it this way: "We are entering a highly competitive era. The keynote of the past several years has been production. Every effort has been made to catch up with the hungry demand of starved markets. Our goal has been tonnage and more tonnage. We have accelerated our equipment and we have added new capacity. The emphasis is now shifting from production and quantity to performance and quality. In my judgment this is a healthy emphasis and we may expect it to prevail for several years to come. It is necessary, however, that we all recognize that this new era will require us to pay more attention than ever before to conservation—conservation of raw materials, conservation of resources, conservation of labor. If I may use a much abused word, "efficiency" is again coming into its own."

Efficiency in its broadest concept involves a welter of interrelated and overlapping ideas. These ideas are variously expressed more broadly as organization, control, and cost reduction. In more detailed form organization is subdivided into such phases as responsibility, delegation, accountability, authority, supervision, and improvement or staff functions. Control and cost reduction are designated in detail as standards, incentives, standard costs, budgets and breakeven point analysis. It is the scope of the above with particular reference to development of the basic operational and engineering standards and working to the point at which it is handled as an accounting function, that we designate as cost engineering.

Cost engineering defined in a general way consists then of the somewhat overlapping processes of control and cost reduction and the proper organization to effect them. Our industry during the past thirty years has, as a whole, progressively developed a considerable degree of control over its operating processes and has made many important cost reductions in the larger chunks through sound mechanical and chemical engineering techniques in the form of increased speeds,

(continued on page 16 A)

An address presented at the Fall Meeting of TAPPI, Portland, Ore., September 12, 1949.

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(continued from page 14 A)

new equipment, material, and heat savings. We have, however, possibly not as yet realized all the potential benefits available through the full use of the relatively newer industrial and cost engineering techniques for control and cost reduction in the form of analysis of operating methods and exposure of the smaller, more numerous excess costs and wastes of materials, power, supplies, and labor. Frequently many of such excesses possibly have been overlooked or deemed of minor importance until a formal study is made to express every detailed operation in terms of definite standards which the modern control techniques of standards, standard costs, and budgets require of us.

Most of our past efforts at control have consisted largely of gathering average statistics and accumulating actual job or grade costs tied in with the general accounting system and of attemping to analyze them to determine causes for variations in order to be able to correct them largely to past performance standards. Such analysis was largely futile because of accumulation of many averages of component items and because of hidden variances. Most of us have long since recognized the futility of attempting to use actual costs for pricing because of variations in material inventory values and variations in conversion costs due to under or over absorption of overhead due to volume, and changes in labor, freight, and production rates, to mention only a few. We have all gone through the process of substituting estimated costs by selecting standards from past averages, most efficient performances and many other sources. We have all attempted to combine the estimated costs with a sales forecast to crudely budget future profits and material consumptions. We have gone to great efforts to gain accuracy by use of actual costs when our basic data contains many controversial assumptions which form the basis for the various allocations and prorations of overhead.

As a result of a growing recognition of the limitations of actual costs, the modern concept of cost as stated by Professor Lang* is that "the true cost is the standard cost and the actual cost is important only to the extent that it reveals deviations from a standard." These standard costs are based on physical standards for everything that can be measured. Many of the improvements to be made in a standard cost system hinge around our ability to measure all elements of production better and more accurately calling for engineering techniques of a high order, requiring our combined and cooperative efforts. To work our detailed operating standards and help develop the budgets they will subsequently work under, it is imperative for operating men and engineers to possess an understanding of the basic principles of cost engineering.

The need for control stems largely from the principle of organization that ultimate responsibility in the form of accountability cannot be delegated. Hence a delegant in order to be able to fulfill his accountability to his own superior must establish a system of control to aid in supervision before he can safely delegate responsibility.

Control then is a system or a technique by which a delegant at various organizational levels is informed of an impending or past default of a delegated or even sub-delegated responsibility in terms of who, where, what, when, why, and how much. The system or technique used naturally is different, particularly in detail, at various organizational levels. Essentially separate but coordinated systems must be developed for control of the Continuity of a business at administrative levels, Profits at general management levels, Costs at production management levels, Operation at superintendence levels and Routine at foremen levels. The techniques of control presently available for these various respective levels are the breakeven point analysis, budgets, standard costs, standards and records, standard practice, and sign posts. These techniques in reverse order, beginning at the bottom, form a part of the scope of the subject matter of cost engineering.

In order to build systems of control for various levels of organization, and make provision for improvement functions of quality improvement and cost reduction, organization must make provision for the staff or improvement function as well as the line or routine function.

All supervisory jobs bearing any part of the delegated production responsibility from administrative management through general management, production management, superintendents, and foremen, possess two ever present phases in common: the routine phase and the improvement phase. Organization must make provision for these two phases to be fully effective. In many cases at various organizational levels the two phases are merged in the activities of one person if the capacity in terms of time available and technical ability of a single person permits.

The modern trend, however, is to recognize that in most cases this condition does not hold because of limitations of time, capacity, education, or experience and consequently the two phases are separated by the organizer into the line and staff phases. Improvement, the staff phase, requires continuous and often long-time application and study to problems for solution while controlling the routine, the Line phase, involves minute to minute planning and quick decisions with many interruptions to cope with sudden exigencies. Dealing with the new and unknown requires analysis, research and experience from a wide range of contacts while dealing with the known or routine requires a great fund of detailed experience within a more specialized field. Each of the phases require great differences in experience, training, temperament, and native ability.

One important staff function, which is an important phase of Cost Engineering, lies in the field of cost reduction. As phrased by Caminez,† present day conditions of competition have effectively changed the equation from "Cost plus Profit equals Selling Price to Selling Price minus a reasonable profit equals Cost Objective." As the result of the general efficiency level, cost reduction in our industry in general no longer is available in large chunks. In the future cost reduction will largely revolve around getting a little from many places. We will all be required in the future

* "Concepts of Cost, Past and Present," by Theodore Lang, NACA Bull. (July 15, 1947).

† "Budgets for Cost Control," by David B. Caminez, NACA Bull. (Nov. 1, 1946).

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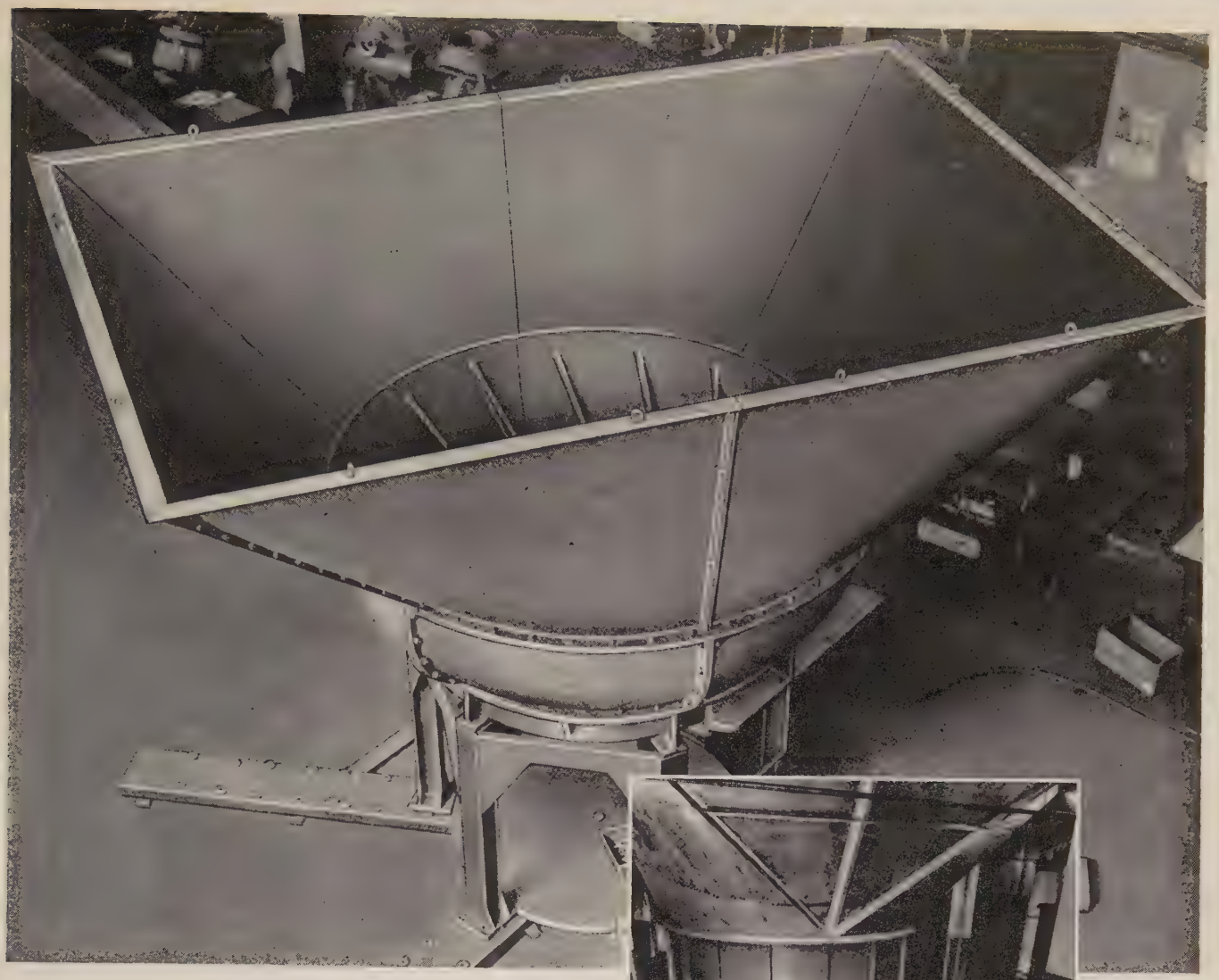
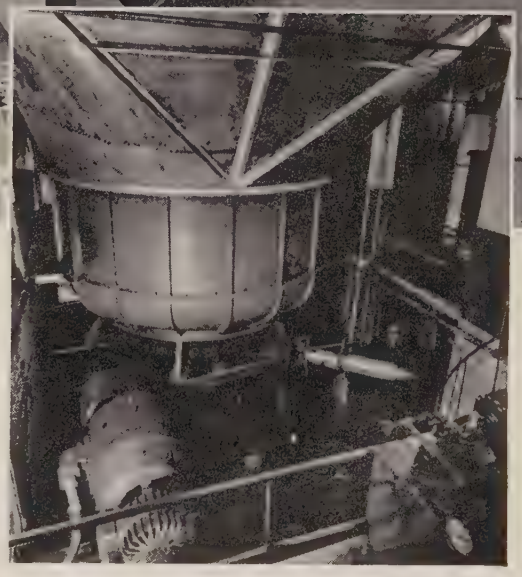


For a Swiss Installation.



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WHAT! NO BROKE?

You're kidding. All mills make broke and have to do something with it and pronto.

Some worry it thru Hollanders. Some drag it off to a distant breaker. The best way is to drop it to a Hydrapulper just below the calenders.

No fuss and less labor. No danger of returning dirty broke to the system.

Hydrapulpers for broke-handling may be standard units or special ones with distinctive broke-handling features. Here shown are a few with flaring tubs, built to special specifications.

A wealth of material on broke-handling available, so let us hear from you.

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(continued from page 16 A)

to do more things well with fewer mistakes in the form of waste of man-hours, materials, B.t.u.'s, kilowatt hours, machine hours, and waste of management hours.

One of the most important and first prerequisites to a program of cost reduction is a comprehensive and adequate system for quality control and the staff function of quality improvement. Quality control and quality improvement are of themselves a source of cost reduction. By controlling to consistent standard quality and working constantly to improve the general level of the standards and mill work more volume is attracted which will result in reduced fixed costs due to greater absorption of overhead as well as even some reduced variable costs.

The real goal of cost reduction then is not only to control quality while reducing costs, but to actually improve it. While such a goal might seem incongruous indeed, as we look over the accomplishments of the past all of us can find many instances within our own experience where quality has been materially improved while costs have been reduced.

The basic requirement of a system of coordinated control through the various organizational levels is a set of adequately engineered standards for practically every phase of operation, including yields, shrinkages, machine changes, delays, labor performance, machine speeds, broke, felt, and wire life, etc., as well as more difficultly measured ones, such as kilowatt hour flow of water in the river, etc.

The development of standards into standard costs and standard costs into budgets, to produce the variances from predetermined profits, is beyond the scope of this particular discussion. Essentially the standard cost and budget system brings out all the contributions to the profit plus and minus by operations, individuals, and causes. Knowledge of the undistorted facts is the first step in the elimination of excess costs. Essentially, also, a standard product cost is the cost. If we add to this the variances in the form of mistakes, accidents, wastes, and conditions outside of control, such as economic conditions and even weather conditions, we will produce the actual cost if such a mixture is of any use for control purposes. The controllable inefficiencies clearly separated and earmarked become the targets for cost reduction.

The breakeven point technique, in the form of the profit graph, finds its principal use as an over-all control of profit to determine whether conditions have caused the profit to deviate from the normal budgeted profit path. It also finds extensive use in forecasting speedily and testing the effects of contemplated policy decisions such as wage increases, price changes, plant expansion, new products, or new equipment. Through this technique the relative effects of profits, volume, prices, fixed and variable costs, and grade pattern can be evaluated in terms of their interplay. Through its use also the general direction for likely cost reduction possibilities can be determined.

The major part of the development work on these controls has been done by the National Association of Cost Accountants, the Production Division of the American Management Association, and most of the prominent consulting Management Engineering Companies. In the past several years, however, comparatively few of the papers of the NACA or AMA have dealt with Paper Manufacturing or Converting operations. It is not our purpose to propose that TAPPI attempt to work cooperatively on the full scope of these Associations, but rather that we attempt to complement their efforts by beginning at our "grass roots" of standards. We need in our industry, in the interests of control and cost reduction, to utilize to a greater degree the techniques in these phases that have been largely developed and consolidated in the past twenty years, as the result of the engineering approach to costs. We need to develop a literature in terms of our own language and our own specific problems, which in many cases are more complex. Thereby cost engineering techniques can be studied without going through the difficult and tiresome process of translation from the specific illustration from another industry to principle and back to specific application in our own industry.

TAPPI in its original scope of committee organization made provision for such a committee as a management committee, which has been inactive for years. This in my opinion was beginning at the wrong end. As the result of the advances in these techniques there is also now much more to study cooperatively with regard to methods of measurement and calculation of physical and engineering standards. Comparison of engineering standards between mills to highlight relative efficiencies or wastes, due to equipment rigidities and methods of handling the various applications of the techniques of standard costs and budgets are also other essentially common problems.

Cost engineering is a function that exists to be handled in some organizational form by all companies, whether large or small. Our experience indicates that largely similar functions exist in all sizes and kinds of organizations. In the smaller companies there are naturally fewer people to engage in them. This in most cases simply means doing less of a specific kind of work and more different kinds of work in the smaller organizations.

This idea does not necessarily contemplate making production technicians or engineers into cost accountants or vice versa; but merely of giving recognition to a growing function that exists to be performed to advantage in order to enable management to control with the benefit of the latest techniques. Many organizations within and without our own industry have already given recognition to the existence of this function by using industrial engineers, engineers and production technicians as members of their accounting staffs. In other cases production management at high organizational levels have attached cost accountants to their staffs for development into cost engineers.

The various control techniques of cost engineering are in many phases only 10–25 years old. They are no panacea for high costs. They are far from perfect; they need considerable research for better methods of application to our industry which is extremely complex and rather difficult to measure accurately. The fact that our variables are complex makes it all the more necessary to adopt these techniques, despite our difficulties of application, if we are to control in the true

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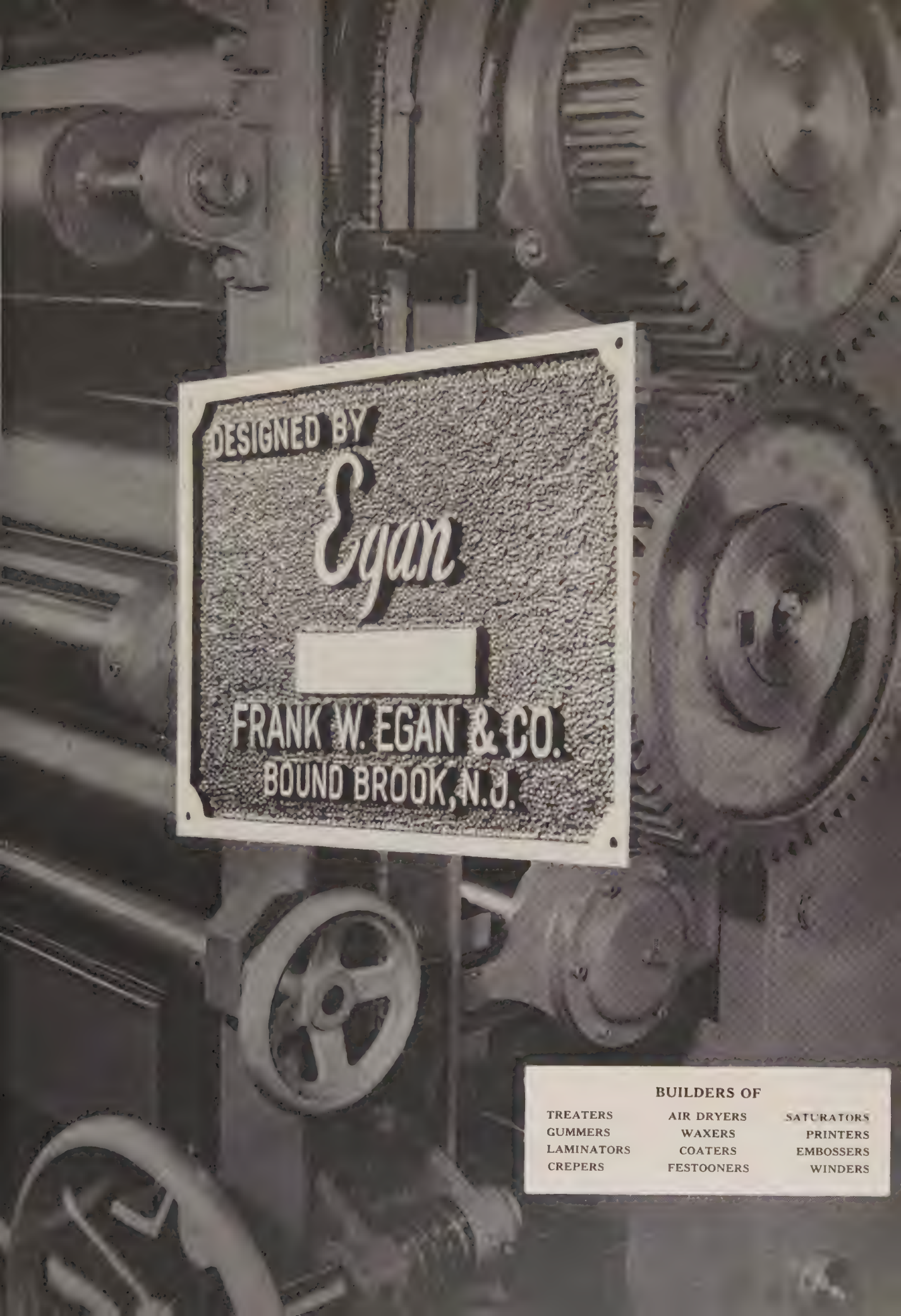

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(continued from page 18 A)

sense of the word and to establish a mechanism prompting the whole organization constantly to continuous and unrelenting cost reduction.

The establishment of an adequate mechanism for control and cost reduction is a long arduous task. It resembles somewhat a maze in that there are many paths that lead to dead ends unless the complete integration of controls is carefully planned. Great preparation in the form of proper system of accounts and the careful preparation of a great many standards are required. Adequate provision for staff work either supplied internally through organization therefor or externally supplied by Management Engineers is also required. The establishment of the mechanism requires a detailed knowledge of the principles of the various cost engineering techniques to some extent centered in the same personnel. A collaboration of operator-engineer with cost engineer with cost accountant is almost essential to successfully solve the problems of application of cost engineering principles.

The constant necessity for making correct decisions compels us to investigate all avenues of possible improvement of our fact finding techniques. Even with the best fact finding techniques and control systems it is often necessary to act with inadequate facts. We need to go into action armed with all the relevant facts that can be mustered at the time. The use of Cost Engineering techniques described offers us an opportunity to act with the assistance of many more facts and hence cannot help but improve the quality of decisions. We need individually to recognize fully the existence of the cost engineering function and to make organizational provision for its inclusion within our operating scope.

There are many difficult problems of application of these techniques on which the cooperative approach of a working TAPPI committee on Cost Engineering will be of benefit to our members and their companies. The consideration of certain of the operational standards of efficiency between mills will be of benefit to the work of some of our other committees, specially the Paper Manufacturing and Engineering Committees. To the large group of operating executives and staff manufacturing men, comprising possibly 30% of our membership, an opportunity is provided to work at a function of specific interest and growing importance. The work of such a committee will develop considerable interest and form a significant background of value to many of our other members also.

To justify its continuance at existing and even greater levels of membership, TAPPI both as an organization and as its individual membership must respond and measure up to the need of the times. The need of the times demands even greater emphasis than ever before on the improvement phases of the functions of organization, quality, costs, standards, and controls. To study together and to develop methods of application of the control techniques in terms of the specific common problems and language of our own industry can become the field of endeavor of a Cost Engineering Committee of TAPPI. We hope the response of our membership will be such that we can proceed with the forming of such a committee.

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Fifty years of cooperation in developing equipment to fulfill the indicated requirements of the industries we serve, have led to our growth from this small beginning to our present world-wide recognition as a source of quality testing apparatus. Industry has put its trust in us, and we look toward our second half-century with appreciation of your faith, and determination to merit it even more.
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THIS IS PRE-LOGGING

Pre-logging is the harvesting in advance of smaller trees which otherwise would be damaged or destroyed if left until the big trees are logged. This isn't as simple as it sounds. To pre-log efficiently meant devising special new and mobile logging equipment.

However, the effort is justified in the recovery of many cords per acre of good clean material, highly desirable in the manufacture of sulphite or sulphate pulp.

Pre-logging fits into the method of "block" harvesting as used in the Douglas fir region, where forest lands are clearcut in a patchwork pattern, leaving blocks of seed trees as a source of regeneration. This is all part of the cycle of growth, harvest and regrowth known as Tree Farming.

Weyerhaeuser's use of the pre-logging method is another step toward more complete utilization of the timber crop.

Management's Job Is Selling

Alexander R. Heron
Vice-Pres., Crown Zellerbach Corp.

The job description for management in any corporation will be different from its job description in any other. Even the concepts of who is management will be different. No one can sharply define the specific tasks of the people who are called "management" in the hundreds of firms or corporations represented here today.

But management is more than the people who have the title of manager in some form, more than managers plus supervisors plus staff advisors, more than any group of people. It is an institution and a system. It is a distinct force in American life, more potent than most of the institutional forces which we commonly recognize. It touches more people than any institutional force with the exception of the home, and the possible exceptions of church and school. It is this institutional force, this management system, that we are considering today.

We are looking at the part which this institutional force must play in the total combination of forces which affect our total life as a people. We are looking at the job which has been assigned to this institution or system in the total job which we call our economy. We are considering the task of management in the drama which we loosely call the American Way of Life. To do this we must glance quickly at the whole picture of our American way, as it is today, and as it changes from generation to generation.

The organization of the relationships between people of the United States of America is a very flexible one. In our political structure, the Constitution was drawn with simplicity, and with ways and means for changes within itself. Not only in more than twenty amendments, but in the evolution of interpretations of the constitution by the Supreme Court, the flexibility of our basic governmental structure has been demonstrated.

In the organization of our economic life, we have had even greater flexibility. The fundamental concept of the rights of private property has never been abandoned, but has changed and grown. One big series of changes resulted from the creation and growth of corporations. These, by interpretation of the Constitution, came to have many of the rights of persons, particularly the rights to private property. A long series of changes in another direction has limited the rights of everyone to the full use of his own private property. One industry after another has fallen under public regulation, and has come to be defined as a public utility, an activity heavily weighted with public interest. One occupation after another has become subject to regulation or licensing. Even the personal earnings of individuals have been brought partially under government control, as to amount and as to their use by the earner.

All these changes have been justified as steps to protect the interest of individuals, and of people as a whole. Some of the changes brought franchises and regulations of services and rates for transportation companies or gas companies. Others required certain standards of training and experience for physicians, barbers, or building contractors, others brought minimum wage laws and compulsory social security.

Partly as a cause and partly as a result of these changes, the nature of property has changed and the nature of employment has changed. In the days of the Constitution, property consisted chiefly of real estate, money, notes and mortgages, the tools and equipment of a craftsman. Today most of these kinds of property are owned by artificial corporations instead of by natural persons. The majority of American families still own their homes, but the majority of American craftsmen do not own their tools. The majority of our mills and factories are not owned by the grandsons of the founders, but rather are owned by corporations. As far as natural persons are concerned, individual human beings, most of their property is in the form of what we call intangibles; shares in the ownership of a corporation, bonds of corporations or national, state or local governments, equities in insurance policies, rights to old age pensions from private or public sources. And another form of property is slowly being recognized. It is the right of a wage earner to a job. In the case of tens of millions of American adults, this intangible claim to a job is the principal or only form of property.

When the Constitution was adopted, less than 10% of our population consisted of wage earners, as we understand the term today. Over 90% of the free adult males were self-employed in one way or another. The overwhelming majority of skilled workmen were in business for themselves, in the sense that they sold their services directly to the ultimate consumer. The

(continued on page 24A)

An address by ALEXANDER R. HERON, Vice-President, Crown Zellerbach Paper Corp., San Francisco, Calif., given at the fall meeting of the Technical Association of the Pulp and Paper Industry, Portland, Ore., September 15, 1949.

for color in boxboard

BISMARCK BROWN RX CONC. Dustless

BISMARCK BROWN RX CONC. DUSTLESS is tinctorially one of the strongest of basic colors. It is a standard requirement for producing browns and tans, and it acts as a dulling agent for the brighter Acid, Basic and Direct colors in both sized and unsized papers.

Although BISMARCK BROWN RX CONC. DUSTLESS does not work well on bleached fibers, its excellent solubility recommends it for both beater and calender coloring.

Specify BISMARCK BROWN RX CONC. DUSTLESS for such paper applications as kraft, poster, tissue, wrapping and boxboard.

AMERICAN Cyanamid COMPANY

CALCO CHEMICAL DIVISION,
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(continued from page 22 A)

cabinetmaker sold his services directly to the man who wanted a new table built for his kitchen. The journeyman painter usually sold his services directly to the home owner whose house needed painting, or the tradesman who needed a new sign. The shoemaker sold his services to the families who ordered new shoes to be made on his last. The harness maker usually worked in his one-man shop, making harnesses for the men who owned horses. If a suit of clothes was not made in a home, it was bought directly on a special order from the craftsman who sold his time and skill to the man who was going to wear the suit. The blacksmith sold his skills to the farmer who needed a new plowshare, or to the city dweller who needed new iron tires for his wooden wagon wheels. The wagon itself represented a direct sale of the time and skill of the wagon maker.

There were exceptions to this form of organization of 1790. There are remainders of this form of organization in 1949. But the dominant ratio has been reversed in the intervening years. In 1949, we have some 60 million people gainfully employed. Over 80% of them, some 50 million of them, are on somebody's payroll. The most skillful workmen in the modern automobile factory cannot possibly sell his time and skill directly to the man who wants an automobile. The man who works at making shoes has no idea who buys and wears the product of his work. The "hired girl" who preserved the fruit or dried the apples for one family has been succeeded by hundreds of thousands of girls in commercial canneries, girls who never see the users of their products. It is a rare blacksmith who can find a personal purchaser of a plowshare, but hundreds of thousands of men work in the agricultural implement factories. The village dressmaker has given way to a million job-holders in the thousands of factories making Ladies Ready-to-Wear Apparel.

The craftsman who could make paper in 1787, and sell it to a few nearby printers and lawyers and schoolmasters, cannot sell his services in that way today. He is one of 300,000 workers in the mills and converting plants of a great industry. He never sees the final customer, the real user of his time and skill.

Of course, the change from small-scale to large-scale manufacture has been significant. It has helped to create our standard of living. It has made possible our possession of one automobile to every four people. It has made possible our scores of millions of radios and refrigerators, our fifty million telephones. It has given us our average of more than one newspaper and more than one magazine per family, our total yearly use of almost 360 pounds of paper products per capita.

It has also been significant in its demand for great pools of capital. No individual, no matter how much money his father left him, can today create a General Motors or U. S. Steel. Even a modest paper mill requires the pooling of the savings of many people to provide its plant. Perhaps even greater capital must be provided for the plant which builds the paper machine, and still more for the steel company which furnishes the steel to that plant.

All these changes are significant, but the most important change of all is the separation of the worker from the customer. In 1787, some 90% of the free men in America were selling their services directly to the users of the product. In 1949, more than 80% must depend on someone else to do this selling for them. It is this dependency which has created the most significant job for the institution we call Management.

The flexibility of our political and economic structure has made these changes possible. No nation without our flexibility has recorded any such achievement. The nations which have had structures nearest to ours in flexibility have raised their standards of living nearest to ours. The nations farthest from us in the rigidity of their systems have progressed the least. But this flexibility means that every institutional force in our economy is forever on trial. If any institution fails us, we can and will change it for some other system. This includes the institution of Management.

What are the tasks which management must perform, in our total economy, if it is not to fail? What failures would cause us as a nation to abolish the management system? We are not concerned with the failures which would cause individual managers to lose their jobs, to be replaced by other managers. We are concerned with the failures which would cause the institution of management to lose its function in the total economy. It is a vital and timely question, because this institution of management has already lost most of its function and influence in the world, outside our own continent. Dr. Richard Gettell of *Fortune* magazine recently said, "American business management is the guardian of the only free economic system left in the world."

Management obviously has the responsibilty in America for ideas and plans, for securing capital, locating, designing and creating the physical plant, organizing manpower, enlisting research, producing and selling goods and services. For our purpose we can look at two major functions or responsibilities of the management system.

In America, the people who call themselves management are in a position of trusteeship; trusted with the management of the national economy. This is no longer true of management in any other major nation in the world, with the possible exception of Canada. This trusteeship carries with it certain responsibilities. A responsibility is something which we must perform, or suffer a penalty. If management does not perform these responsibilities, the penalty will be the loss of its right, the loss of its trusteeship, to manage the economy.

We all recognize the responsibility on the management system to provide for our needs in the way of goods and services. Management must guide the economy so that there is a sufficient supply of the goods and services required to maintain our standard of living. When management fails to do this, it will be displaced, in whole or in part, by some other system. For reasons which may be debatable, the management system has failed to provide sufficient housing to meet our needs. It is now facing the accomplished fact that it has been displaced from a part of the responsibility in this field, where the Federal government has taken over.

(continued on page 28 A)

HERE'S SOMETHING *NEW* IN

Twisting Tissue

This new twist keeps twisting tissue from breaking in the machine. It's the UFORMITES—urea formaldehyde resins used to wet-strengthen paper. Wherever they are used, tissue can be made into twine more speedily and less expensively.

UFORMITES are easy and economical to use. No pre-treatment or special equipment is necessary. Simply add a small quantity of UFORMITE resin to the pulp before sheet formation. Then wet tissue can be twisted with much less breakage because UFORMITE boosts wet strength 300%. The saving in "breakage-time" more than pays for the resin.

In bag and liner stocks, paper towels, glassine, locker wrap, map paper, blueprint and tag stocks too, you'll find the UFORMITES giving maximum strength at minimum cost. In Kraft stocks, a three-fold increase in wet tensile strength is typical. And similar increases can be obtained in both sulfite and groundwood stocks. Write today for full details of the UFORMITES.

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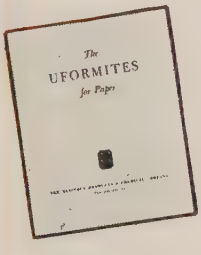

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CHEMICALS FOR INDUSTRY

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In 1/120 of a second Limitamp operates to prevent the spread of short-circuit damage. These controllers are not only quick acting (because of special EJ2 fuses), but the contactors are especially designed to stand up under several million operations—providing much longer life than is usually possible for such high-voltage equipment. Limitamp is also applicable for semi-hazardous or corrosive atmospheres.

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(continued from page 24 A)

The second fundamental responsibility of the management system has not been fully recognized. It is the responsibility to provide jobs. We have pointed out that more than 50,000,000 people in our complex economy must be on some payroll, because they cannot sell the products of their work directly to the consumers of those products. Management has the responsibility of combining the time and skills of each of these 50,000,000 workers, with the time and skills of others, with tools and power and design and advertising. If the management system fails to provide a reasonably adequate number of jobs, it will be displaced from this primary responsibility.

The objective proof of this statement is clearly before us. When the system failed to provide enough jobs in the depression of the 1930's government inevitably stepped in and provided jobs, some of them real, most of them frankly counterfeit. Many of the jobs were in competition with the efforts of management to provide jobs. The second chapter in the lesson can be read in a number of bills proposed to recent sessions of Congress. It is necessary to look at only one of them, which is on the docket of the 81st Congress. It is not likely to become law until there is a serious failure to provide enough jobs. When and if it does become law, the government will be providing jobs, not at leaf raking, but at the actual production of needed goods, beginning with steel. If the people who consider themselves part of the management system want to keep that status, and want to sustain our privately managed economy, they must not fall down on this responsibility of providing an adequate number of jobs.

Obviously the only way that management can provide jobs is by selling the product of those jobs to people who are willing to pay for it. Strange as it seems, this is the only way that government can provide real jobs; but government has the ability to sell by the use of pressures which destroy the freedom of the customer. Even the leaf raking of the '30's was sold to the people of the United States. If you have any doubt of that in your mind, look at the election results in 1936. In that November, the majority of the voters in all but two states marched up to the polls and marked O. K. on the invoices for leaf raking. Under the pressures applied to them, the American people were willing to buy the worthless products of jobs, so that 13,000,000 families could eat.

In the present turn of the economic tide, management has a baffling collection of problems. It must purchase its supplies of materials at lower costs. It must reduce its labor cost per unit of product. It must absorb certain fixed overhead into a reduced volume of output. It must trim sail in a hundred ways, to conform to the adverse winds. In doing all of these things, too many people in management have forgotten the most important activity of management. That is the activity of selling.

Through the years, we have failed to recognize that this is the primary responsibility of management. We have forgotten to recognize it in our activities of engineering, research, technical control, purchasing, traffic. We have failed to tell the truth about it in our labor relations. We have allowed ourselves to become involved in debates over cost of living, ability to pay, national wage patterns, fringe benefits, and the ever present danger of strikes.

When we recognize that selling is the primary responsibility of management, many of our habits and relationships will be changed. When the spokesmen for labor unions believe that management has honestly accepted this as its primary responsibility, the attitudes and tactics of those leaders will surely change. When workers realize that they must have the services of management as the selling agency to create jobs for them, the attitude of those workers toward their jobs will change. When the worker realizes that he must select, and in effect hire, a certain management to sell his time and skill for him, he is intelligent enough to help that management sell the product of his work.

The penalty on the worker, if the management system fails, is infinitely greater than the penalty on managers. If we ever pass into an authoritarian economy, most of us in middle management will not suffer greatly. Most of you would be needed in the bureaucratic organization which would displace the present management system.

The average worker would also have a job of sorts. Of course, he would have to work where he was told to work, at wages fixed by the bureaucrats. He might even have a dominant voice, throughout the system of elections, in choosing the men to serve as bureaucrats. All history shows that he would have to accept a lower standard of living.

These things are all unpleasant prospects, but not nearly as unpleasant as the fundamental change which we all must face. The worker as a consumer would lose the freedom which he uses more often, in more different forms, than any other. He would lose his freedom of choice as a consumer. He would lose the right to select the kind of automobile he wants. Under a controlled economy, with competition eliminated, he could no longer choose his suit of clothes from the offerings of 15,000 competing manufacturers. Under a controlled economy, it would be silly to maintain two morning newspapers in the same city. You and I and the other workers could no longer buy the paper we like. We would take the paper published by the Bureau of Newspaper Publications, or none.

In short, one of the most important differences between the authoritarian state and our American free economy, is in the field of selling. Our American idea of selling is inseparable from competition on the one side, and freedom of choice on the other side. Monopoly of any kind, and most of all monopoly by government bureaucracy, eliminates competition. When competition is gone, we as consumers no longer have any freedom of choice. The selling under a bureaucracy is done by force and pressure. The selling under our American system reflects the most dramatic freedom which exists, freedom of the consumer to buy what he wants; a radio set that he wants, so that he can listen to the program he wants; the food that he wants, the means of transportation or recreation that he wants, the kind of furniture, and the kind of haircut that he wants.

The loss of competition is the loss of our freedoms of choice. That loss is the end of all freedoms. It

(continued on page 30 A)

An example of chaetomium globosum (cellulose destroying mold) magnified 76 times

There's no money in growing mold!

Mold and bacterial action can play havoc in almost any pulp and paper manufacturing process. Whether these microorganisms grow in lap stock, pulp slush or in some products such as adhesives used in finishing—they can cost you plenty in time and money.

But you can effectively control these losses with Dowicides, Dow's industrial germicides and fungicides. In practically all phases of paper manufacture, Dowicides are recognized as the most valuable form of insurance against mildew and rot. For example, papers used to wrap or package articles high in moisture content have for many years incorporated Dowicides as a protection against mold.

There's no money in growing mold. Investigate Dowicides now! Complete laboratory facilities are maintained by Dow to help you solve your problems. Just contact your nearest Dow office or write direct to Midland.

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Germicides and Fungicides

DOW

CHEMICALS INDISPENSABLE TO INDUSTRY AND AGRICULTURE

(continued from page 28A)

means that eventually any interference with the conduct of burcaucratic business management is subversive.

We know that we can maintain our freedoms with a large amount of government in business, but how much? A government monopoly in the postoffice and highway business has not enslaved us. Government control of banking has not eliminated private investment, but it has the power to do so. Social security has not abolished private insurance. Our task is not to oppose every economic or industrial activity of government.

Ours is the positive task of proving what we all believe, that the management system can do a better job of meeting our needs for goods and services, and of creating enough jobs. Our most important task today is to sell as never before, to customers who still have the freedom of choice. As we do this greater selling task, we create the jobs which fifty million workers must have. We protect the status of the management system as the essential factor in our free economy. We protect the customer in his freedom of choice of what he will buy, and the worker in his freedom of choice of where he will work.

The preservation of these freedoms is in the hands of management. The method by which management can protect them is selling. Selling means more than calling on the customer and advertising in the proper media. It means quality, price, service, research. It includes the contribution of our own purchasing agents, engineers, chemists, technical control men, safety and personnel men, supervisors, and maintenance mechanics. It includes the cooperation of the managers of the trade unions and of every worker on the payroll.

The end purpose of every hour reflected in our payroll is the sale of an acceptable product to a willing customer. Management's job is to enlist every man on every payroll in this selling job—and to do it before it is too late.

RECENT BOOKS

After the Whistle Blows. By Jack Petrill. The Industrial Recreation Bureau, New York. 1949. Cloth 6 × 9, 351 pages. Illustrated $10.

The administration of industrial recreation programs is covered in this book, giving the advantages and disadvantages of centralized programs, the four phases of industrial recreation, organization and responsibilities, internal organization of the plant, finances, facilities, activities, leaders, public relations and publicity, unions, an analysis of leisure time, gambling in plants, actual case histories.

In view of the extent to which many pulp and paper companies have gone in dealing with this phase of industrial relations this book should be of considerable interest.

Papier im Druck. By Hans Kotte. Carl Garte Verlag, Einbeck (Niedersachen), Germany (in German). Paper-bound 6 × 8, 104 pages and several pages of paper samples. 1948. (Available through M. Treukner, 70 Broad St., New York 4, N. Y.) $1.80.

This is an elementary treatise prepared for the graphic arts and paper converting industries giving an account of the nature of paper and its suitabilty for printing and other forms of conversion.

Physics and Chemistry of Cellulose Fibres. By P. H. Hermans, Director of the Institute for Cellulose Research of the A.K.U. Utrecht, Netherlands. Elsevier Publishing Co., Inc., New York. 1949. Cloth 6 1/2 × 10, 533 pages. Illustrated. $9.50.

This book which requires a good foundation in cellulose chemistry, is included in Elsevier's Polymer Series and pertains particularly to rayon. The author who is the chief chemist of a rayon manufacturing plant endeavors to present a comprehensive treatment of the views and results of purely scientific interest which seems to him to be fundamental for further research work in the field of rayon. Some chapter titles are Micellar Constitution of Cellulose, Cellulose Solutions and Gels, Relationships between Native and Regenerated Cellulose, Morphology of Cellulose Fibers, Optical Properties, Chemical Reaction in Fibers, Viscose, Spinning, Nature of Rayon.

Vocabulaire Papeterie. French-English and English-French. By M. Argy, Director of La Papeterie and H. L. Supper, Manager of Lebois Printing Plant, Paris, France. La Papeterie, Paris, 1949. Paper-bound 4 1/2 × 7, 229 pages. $2.25.

This book is a technical vocabulary for the pulp, paper, and graphic arts industries. Each part contains about 5000 words or terms used in these industries and several conversion tables for paper sheet sizes. Maurice Argy, Editor of La Papeterie is a member of TAPPI.

High Molecular Weight Organic Compounds. Edited by R. E. Burk, Plastics Dept., E. I. du Pont de Nemours & Co., and Oliver Grummit, Western Reserve University. Interscience Publishers. New York. 1949. Cloth, 6 × 9, 330 pages. $5.50.

This book is Vol. VI in the frontiers in chemistry series, published under the auspices of Western Reserve University. The chapters are based on lectures given by such leading scientists as Drs. Herman Mark, Harry L. Fisher, John T. Edsall, Paul J. Flory, and T. S. Carswell who cover such subjects as polymerization in supervision and emulsion, elastomers, protein, condensation, and phenoplasts. Each of these major subjects are brought up to date by the authors.

Monomers. A Collection of Data and Procedures on the Basic Materials for the Synthesis of Fibers, Plastics, and Rubbers. Edited by E. R. Blout, Polaroid Corp., and W. P. Hohenstein and H. Mark, Institute of Polymer Research, Polytechnic Institute of Brooklyn, 1949. Interscience Publishers, Inc., New York. Loose-Leaf Binder 6 1/2 × 9 1/2, 350 pages. $7.50.

This is an accumulation of reliable and up-to-date pamphlets contained in a post binder. The loose-leaf arrangement indicates that more material on the subject will be available in pamphlet form from time to time and will be obtainable on a subscription basis.

It is the thought of the editors that a service such as this would be desirable for those interested in the preparation and collection of polymers. The pamphlet arrangement covering in the present issue acrylonitrile, butadiene, isobutylene, isoprene, methyl methacrylate, styrene, vinyl acetate, and vinyl chloride provides a convenient form of presentation and offers unlimited opportunity for future expansion.

* * *

Copies of all books reviewed in this issue may be obtained through Tappi, 122 E. 42nd St., New York 17, N. Y.

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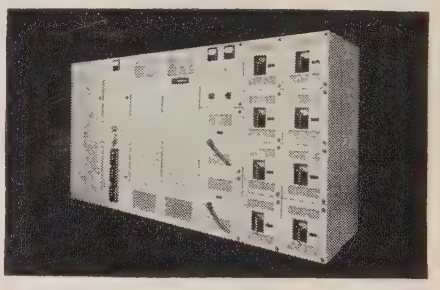

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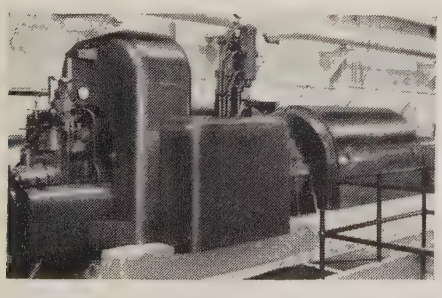
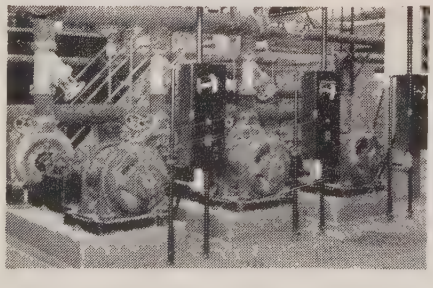


TURBINES — Constant process steam pressure and constant speed are maintained by this modern, 3,000-kw, double-bleeder turbine, a unit of the Westinghouse complete line.



AUXILIARIES — Boiler room auxiliaries driven by Westinghouse motors and control assure continuity of service and give the desired flexibility of operation.

STOKERS — Ability to burn cheaper grades of fuel and to eliminate smoke nuisance are two outstanding advantages of Westinghouse "Link-Grate" Stokers.

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PLANTS IN 25 CITIES . . . OFFICES EVERYWHERE

Two Outstanding New Installations on the Pacific Coast

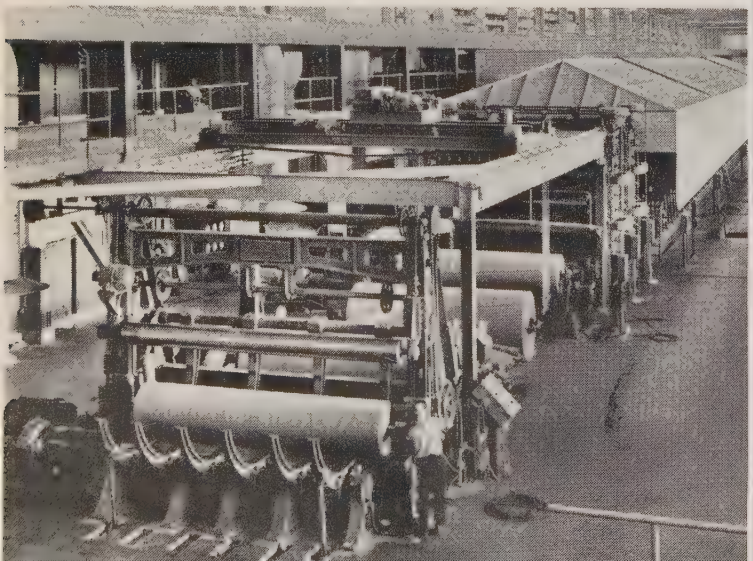
Two new Puseyjones Machines are now in operation on the Pacific Coast—at the East Antioch mill of Fibreboard Products, Inc.; at the Tacoma mill of St. Regis Paper Company. New in design . . . new in outstanding features . . . new in high speed, large tonnage production. Whatever your papermaking problem may be, we will gladly show you what's new in Puseyjones Machines and what's on the boards for the future.

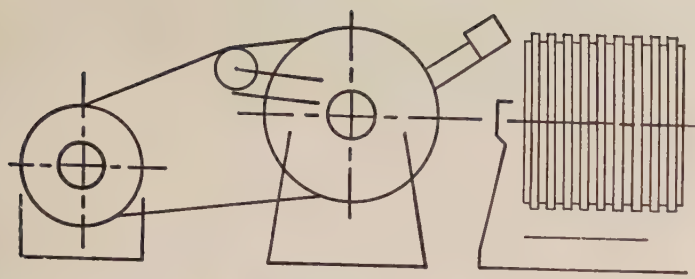
THE PUSEY AND JONES CORPORATION
Est. 1848. Builders of Papermaking Machinery
Wilmington 99, Delaware, U.S.A.

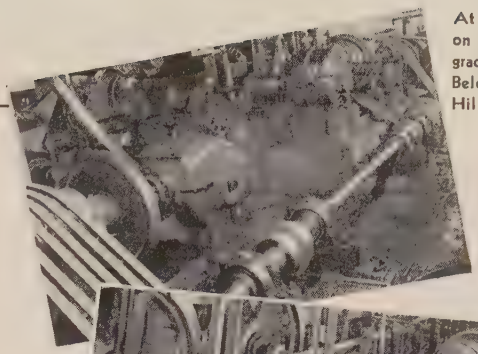
THE SIGN OF TRADE MARK SUPERIOR QUALITY

Two views of new Puseyjones Machine at Fibreboard Produc East Antioch, California. Wire width is 156 inches. Capacit tons of corrugated liner per day.

Two views of 180" Puseyjones Fourdrinier Machine at Tacoma, Washington mill of St. Regis Paper Company. Designed and constructed for top speed of 2100 F.P.M. making high-test multi-wall Kraft Bag Paper.



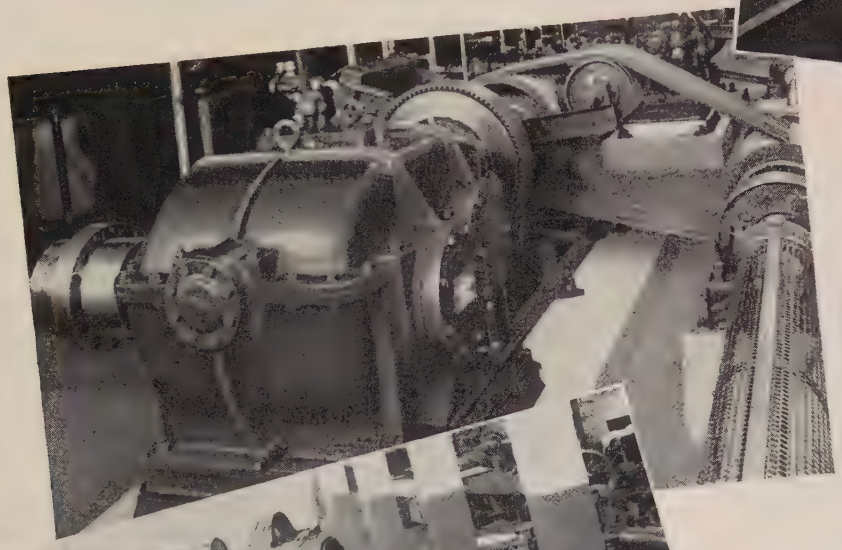


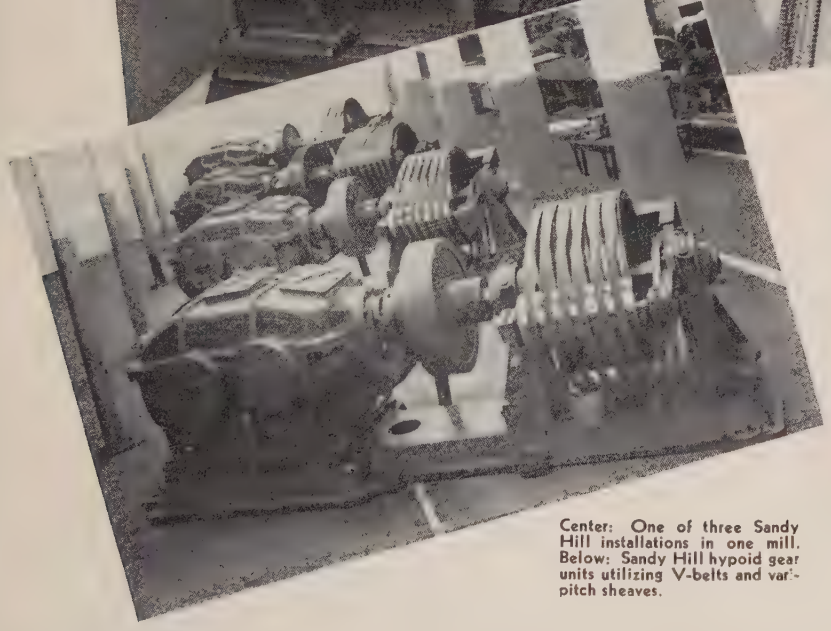


At left: Selective Drive on Sandy Hill high grade tissue machine. Below: Another Sandy Hill installation.

Sandy Hill Drives

for Power...for Control





Center: One of three Sandy Hill installations in one mill. Below: Sandy Hill hypoid gear units utilizing V-belts and variable-pitch sheaves.

Sandy Hill Selective Drives provide the perfect answer to the major requirements of paper machine operators. They provide unvarying draw between sections, fineness of draw regulation, exact draw maintenance, simplicity, efficiency and low first cost.

Sandy Hill Selective Drives are used for dependable power transmission in paper mills throughout the world.

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Some Leading Items:

- Fourdrinier Paper Machines
- Yankee Fourdrinier Machines
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- Bertrams Flow Distributor
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- Pulp Grinders
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- Dandy Roll Drives
- Quick Opening Gate Valves
- Scofield Felt Conditioners
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- Neilson Slice
- Nilsa Bag Machines
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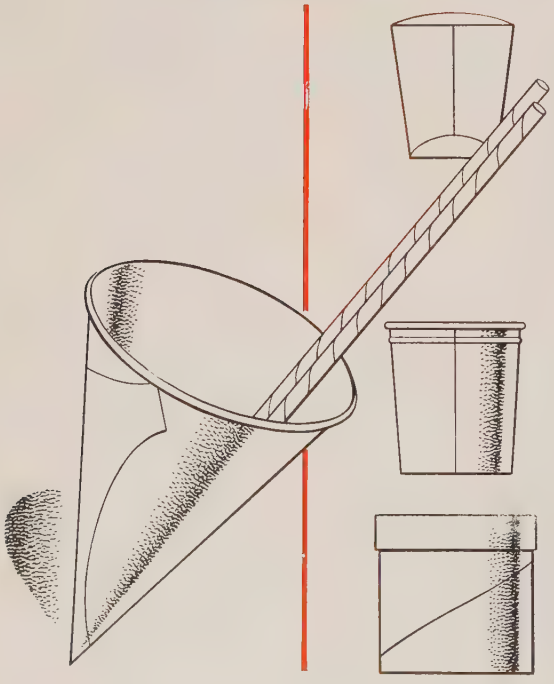

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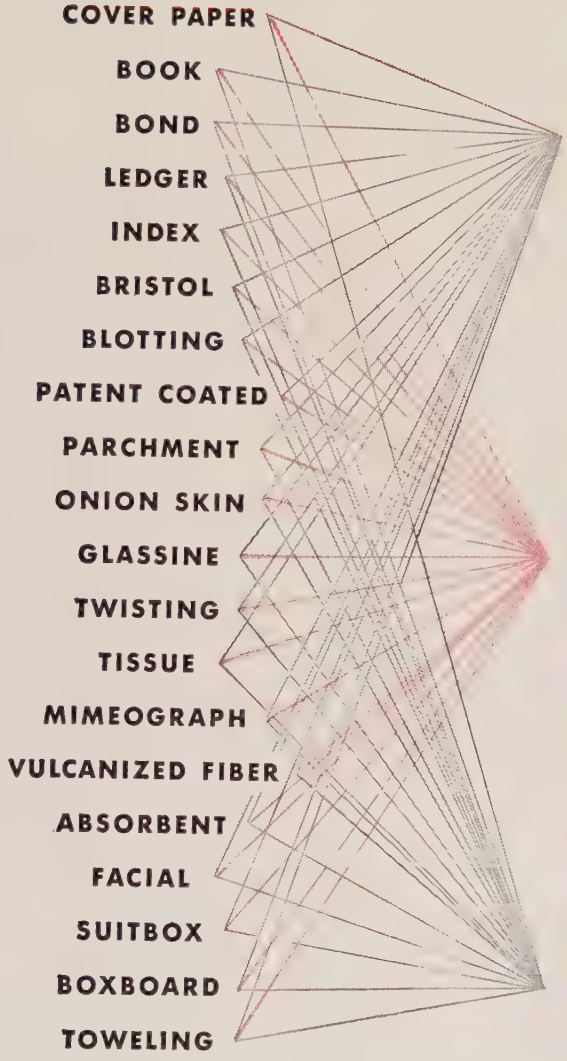

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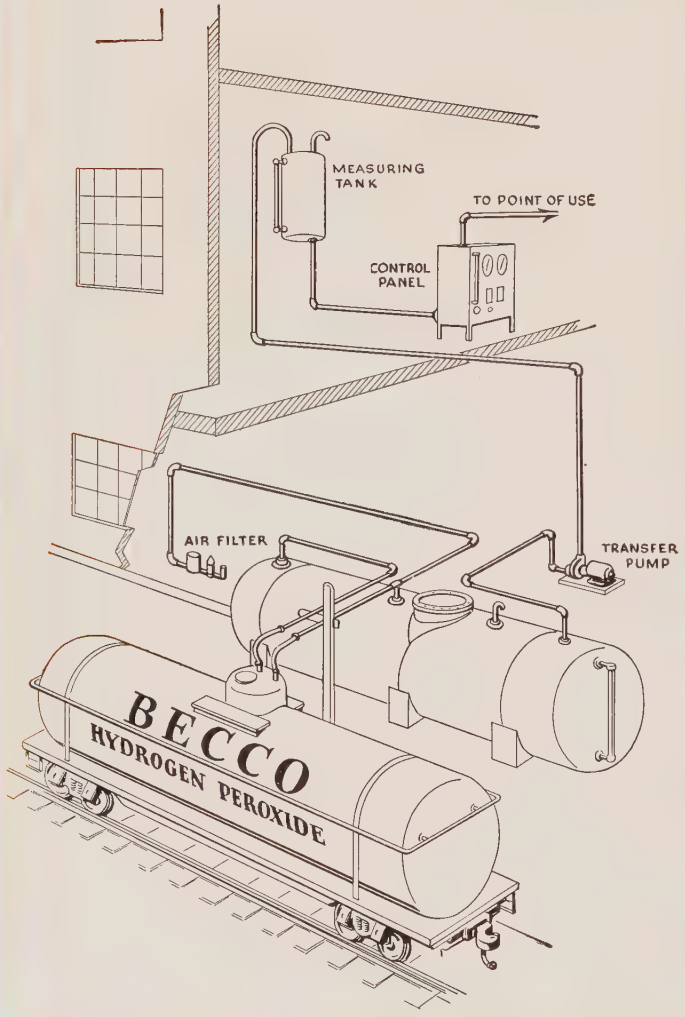

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Suggested Standardization of Spherical Roller Bearings for Wet and Drier Sections of Paper Machines

GEORGE H. SPENCER

Brief reference is made to the basic types of roller bearings available for paper machine applications followed by descriptive characteristics of the spherical roller bearing. Some bearing mounting details are mentioned and reference is made to the theory of predicted bearing life. Paper machines, both fourdrinier and cylinder, are grouped together and suggested standardization in tabular form of spherical roller bearings is given for machine widths 100 to 139 inches, 140 to 179 inches, and 180 to 240 inches at speed groupings up to 800 f.p.m., 800 to 1500 f.p.m., and 1500 to 2000 f.p.m. Basic data for bearing computations are given. Bearing size selection has been made based on 15 years average life. The new AFBMA (Anti-Friction Bearing Manufacturers Association) bearing numbers are shown. Subject matter pertaining to the specific application of various types of bearing mountings for the front side of paper and/or felt driers is discussed. Details and illustrations pertaining to the ladder type method of providing for axial expansion are presented.

It was about 35 years ago, in the United States, that the first attempts were made to use roller bearings on the paper machine. At the time, the only available roller bearing types were the tapered roller, the straight roller, and the spiral wound roller, all three of which lacked in their design the inherent ability of compensating for misalignment. On paper machines, the necessity for providing for misalignment arises from (1) normal roll and journal deflections across the machine width, (2) out-of-squareness of machine framing with the horizontal center line of the journals, and (3) infrequent occurrences of misalignment such as warped cast-iron drier heads, unequal settling of machine foundations, and an accumulation in one direction of either all plus or minus tolerances of the several component pieces of framing designed as a supporting medium for the bearing housings of a particular roll location.

There were and are also the misalignment problems encountered on the top roll of any two-roll unit, such as the upper cylinder couch roll, lump breaker roll, upper primary, main, size, and breaker presses in which the upper roll may be hand or hydraulically operated.

For satisfactory operation, it is possible and practical, when using any of the three previously mentioned roller bearing types, to adequately provide for misalignment. An illustration (Fig. 1) shows a two-row straight roller bearing, the contour of the outside surface of outer race being ground spherically about the axis of the bearing. The proper functioning of this type of bearing requires that at the location on the outer race at the load zone that contact pads, one on each side of the race, be provided as a part of both housing end covers with a clearance of 0.010 to 0.020 inch. This type of bearing will rock about its central bottom position and thus compensate for misalignment.

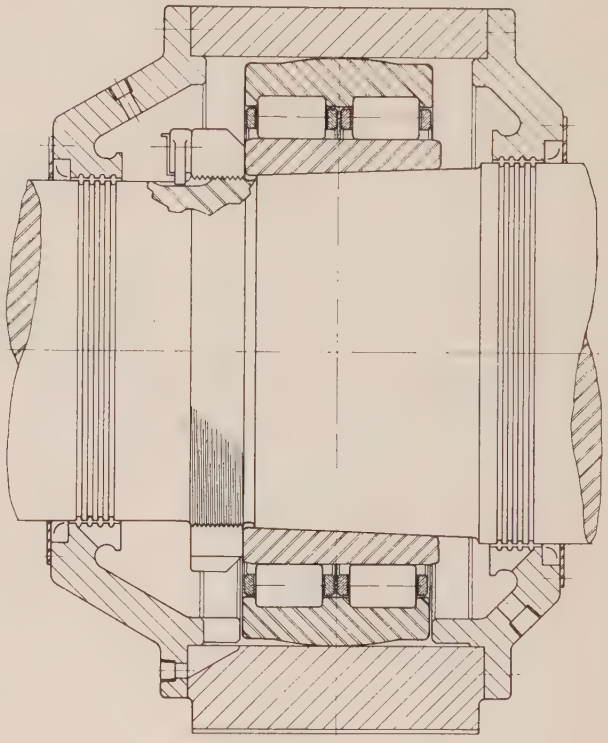

Fig. 1

The illustration in Fig. 2 shows a two-row tapered roller bearing with a hardened steel insert set into a lengthwise machined groove in the bottom of the bearing housing, the outer contour of the steel insert being ground spherically with the center line of the bearing as its axis. The whole bearing housing rests on a second steel piece that is held in its lengthwise position by spacers and side pieces bolted to the framing. A clearance in this case of 0.010 to 0.020 inch between the side pieces and the housing body permits the necessary alignment. It is to be noted that the bearing housing is not bolted to the bottom framing, but is held in position in the crosswise direction by the machined vertical surfaces of the closed framing and in the lengthwise direction by the aforementioned side pieces. Thus, the limitation of this particular bearing mounting is that it is confined, for example, to those applications such as bottom and top rolls of machine and supercalender stacks, embossing machines, etc., having closed framing.

Geo. H. Spencer, Member TAPPI; The Torrington Co., Bantam Bearings Div., South Bend 21, Ind.

As to the question of live bearing load, including shock load, the latter in the case of machine stacks, in relation to the working capacity of the steel inserts, the bottom bearing loading on say a 10-roll, 145-inch machine stack is approximately 56,000 pounds, whereas on the spherical contour member for the upper steel insert, the maximum static non-Brinell capacity at the projected area at the line of contact can be considered at an approximate maximum of 525,000 p.s.i.

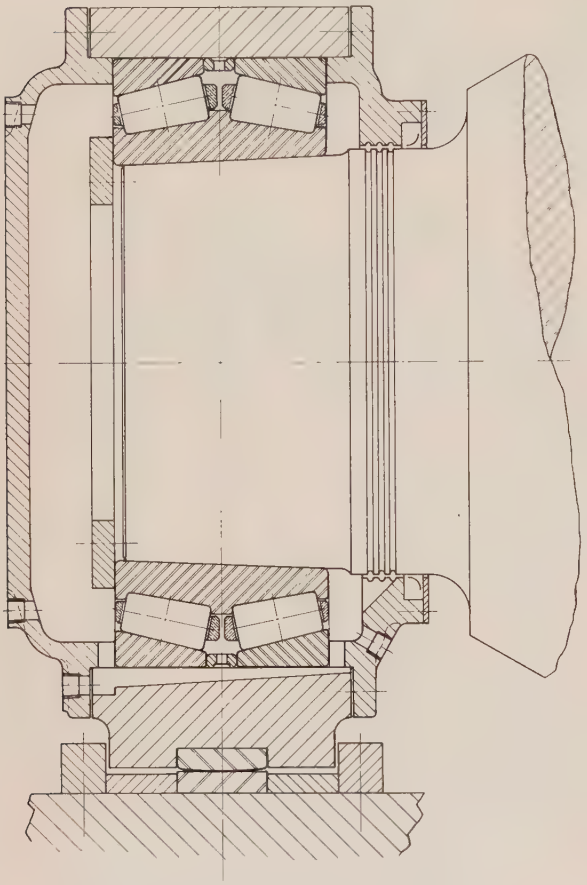

Fig. 2

In this short reference to the methods employed in providing proper means for alignment of rigid type roller bearings, the issue should not be confused by expecting proper compensation for misalignment when utilizing a spherical contour outer race mounted in a similarly machined housing bore. This type of mounting will take care of initial misalignment only and should be confined to short bearing centers where roll and other deflections are almost negligible. The exception to the above comment may occur however, in those cases, even on long bearing centers, where the bearing loads are relatively light.

For example, on narrow width paper machines, say, below 140 inches, the desire for quick and easy wire and press felt changes may be accomplished by providing an inside spherically machined outer housing or cradle equipped with a mating bearing housing and a rigid type bearing. This type of mounting, which in best practice requires that the inner surface of the cradle be babbitted and sometimes separately lubricated, is expensive in comparison to the designs in use on the wider machines using a completely self-aligning bearing in a single housing. However, it is possible and quite practical on narrow machines through the use of bearing housing designs having machined projections at their center lines, to be supported on corresponding sub-bases to use self-aligning roller bearings and thereby gain the resultant advantages.

THE SPHERICAL ROLLER BEARING

The manufacture of the spherical roller bearing in this country started about 1925 and its use on the paper machine has in the intervening years been constantly increased. The chief design feature of this bearing, described by Sackett and Benson (*1*), illustrated by Fig. 3, is that "the spherical surface of the outer race is generated from the center of the bearing and affords the bearing its self-aligning characteristic, since the rollers are free to move around the surface of the sphere without losing their contact and load distribution on the races."

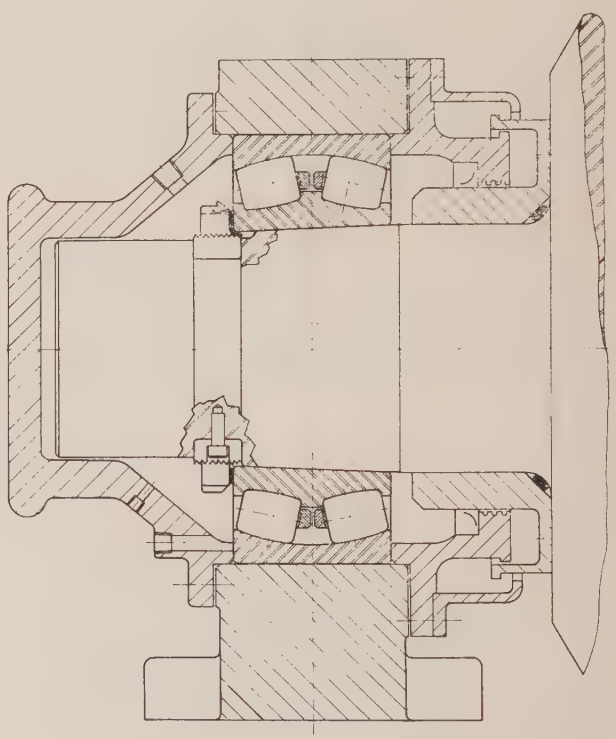

Fig. 3

In the early days of any roller bearing application to paper machines, the problems, some of which in varying degrees of full solution are still present and all of equal importance were: (1) development of workable designs to retain the lubricant within the bearing housing and to keep white and wash-up water and foreign matter from entering it, (2) adequate means for proper lubrication, (3) procedure for complete and proper maintenance, and, finally, (4) selection of the correct bearing size to secure a predicted life.

Bearing Protection, Lubrication, and Maintenance

An accepted bearing protection for the wet and press sections of both fourdrinier and cylinder machines,

referring to Fig. 3, consists of a friction seal, a grooved end cover, a water flinger, and a water shroud. There are several variations of this basic protection, as illustrated in those portions of bearing company's catalogs and previous technical papers devoted to paper machine bearing and housing designs, such as that by DeMott (*2*) and a roller bearing manufacturer's journal (*3*).

For the drier section, the water flingers and shrouds are omitted, but in addition to the grooving in the end covers, there are corresponding grooves machined on the journal in the case of a paper drier bearing mounting.

To assist any possible oil leakage to return to the bottom of the bearing housing, an overflow hole is located in the end cover at the grooving. The use of a friction seal is optional although the basic protection for a drier felt roll bearing, which is usually grease lubricated, is to retain the seal, but eliminate all grooving.

As regards lubrication and maintenance, a literature reference (*4*) gives a résumé of most of the current sources of reliable information on these two vital subjects and also contains brief descriptions of common causes and related race and roller appearances leading to premature bearing replacements.

Selection of Proper Bearing Size

It must be recalled that any material subjected to alternating load, such as the load zone section of the outer race of a roller bearing, that there is a relation between the magnitude of the applied stress and the number of times this stress can be reversed before the material will fail from fatigue. For detail understanding of the theory behind the practice for determination of bearing life and bearing life factors, reference is made to Styri (*5*), and again set forth by Clinedinst (*6*).

Out of these early research works, have come some of the now fully accepted bases for bearing life pre-

Table I. Suggested Standardization of Spherical Roller Bearings for Paper Machines

Machine width, Fourdrinier wire or mold face, inches	*Up to 800 f.p.m.*			*800 to 1500 f.p.m.*			*1500 to 2000 f.p.m.*		
	AFBMA bearing No.	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*
Wet Section—Fourdrinier Machines									
Breast roll									
100–139	100SD23	22320	3.9370	110SD23	22322	4.3307	120SD23	22324	4.7244
140–179	110SD23	22322	4.3307	120SD23	22324	4.7244	130SD23	22326	5.1181
180–240	110SD23	22322	4.3307	120SD23	22324	4.7244	130SD23	22326	5.1181
Table rolls									
100–139	40SD23	22308	1.5748	45SD23	22309	1.7717	50SD23	22310	1.9685
140–179	45SD23	22309	1.7717	50SD23	22310	1.9685	55SD23	22311	2.1654
180–240	45SD23	22309	1.7717	50SD23	22310	1.9685	55SD23	22311	2.1654
Wire rolls									
100–139	50SD23	22310	1.9685	60SD23	22312	2.3622	70SD23	22314	2.7559
140–179	60SD23	22312	2.3622	70SD23	22314	2.7559	80SD23	22316	3.1496
180–240	70SD23	22314	2.7559	80SD23	22316	3.1496	90SD23	22318	3.5433
Wet Section—Cylinder Machines									
Cylinder molds									
100–139 (48 in. diam.)	110SD22	22222	4.3307	....	...	...	....	...	..
100–139 (60 in. diam.)	120SD22	22224	4.7244	....	...	...	....	...	...
140–179 (48 in. diam.)	120SD22	22224	4.7244	....	...	...	....	...	...
140–179 (60 in. diam.)	130SD22	22226	5.1181	....	...	...	....	...	...
Couch rolls									
100–139	85SD22	22217	3.3465	....	..	...	....	...	...
140–179	95SD22	22219	3.7402	....	...	...	....	...	...
Felt whippers									
100–139	85SD22	22217	3.3465	....	...	...	....	...	...
140–179	95SD22	22219	3.7402	....	...	...	....	...	...
Felt squeeze rolls									
100–139	85SD23	22317	3.3465	....	...	...	....	...	...
140–179	95SD23	22319	3.7402	....	...	...	....	...	...
Primary press rolls									
100–139 (upper)	160SD22K	22232K	6.2992	....	...	...	....	...	...
100–139 (lower)	170SD22K	22234K	6.6929	....	...	...	....	...	...
140–179 (upper)	170SD22K	22234K	6.6929	....	...	...	....	...	...
140–179 (lower)	190SD22K	22238K	7.4803	....	...	...	....	...	...
Press felt rolls									
100–139	50SD23	22310	1.9685	....	...	...	....	...	...
140–179	60SD23	22312	2.3622	....	...	...	....	...	...
180–240	70SD23	22314	2.7559	....	...	...	....	...	...

Note: AFBMA (The Anti-Friction Bearing Manufacturers Association, Inc.).

dictions, such as: (1) life expectancy varies inversely as the approximate cube of the load; (2) doubling the load on a bearing reduces its life expectancy to $^1/_8$; and (3) that the minimum life of a bearing, or bearings, in 90% of a group of bearings, could be as low as $^1/_5$ of the average predicted life of the entire group. Also, the life of 10% of the group is not predictable.

The purpose of this paper is not to present a discourse on the theory of predicted life, but to present, as a result of accumulated data, observations, and experience over the years, a suggested standardization for the use of spherical roller bearings on paper machines. The bearing sizes as shown in the following tables, were based on an average predicted life of 15 years of operation considering a maximum working year of 8210 hours which is a full-hour year minus 550 hours for felt and wire changes and a two weeks' shutdown period for repairs. These hours of operation can be converted into millions of revolutions on any given bearing application which method of bearing calculation is now in prevalent use by one of the leading manufacturers of roller bearings.

Referring to Table I, it will be noted that paper machines have been divided into three speed groups, namely, up to 800 f.p.m., 800 to 1500 f.p.m., and 1500 to 2000 f.p.m. Also, widths of paper machines have been divided into three groups which may or may not correspond to a given machine builder's widths, as some builders may have only two sets of framing, some three sets, and others possibly four sets.

From the standpoint of bearing selection, however, there is not enough difference in the various capacities and relative cost of bearings to break down the machine widths to less than the suggested three groups. Obviously, the bearing size calculations for each group have been made for the maximum speed and load data for that group which means that any user of a machine of a width coming in the first part of any speed group would be securing increased bearing life over the aforementioned 15 years' average life. All know that paper machines and framings last longer than 15 years, and sometimes the question is asked as to why roller bearing sizes should not be selected to match the life of the framing. It has been found by analysis that the increased bearing and framing costs to attain such a goal would be impractical.

Table II. Suggested Standardization of Spherical Roller Bearings for Paper Machines

Press Section—Both Fourdrinier and Cylinder Machines

Machine width, Fourdrinier wire or mold face, inches	*Up to 800 f.p.m.*			*800 to 1500 f.p.m.*			*1500 to 2000 f.p.m.*		
	AFBMA bearing No.	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*
				Main press rolls					
100–139 (upper)	160SD22K	22232K	6.2992	190SD22K	22238K	7.4803	190SD32K	23238K	7.4803
100–139 (lower)	190SD22K	22238K	7.4803	200SD22K	22240K	7.8740	200SD32K	23240K	7.8740
140–179 (upper)	190SD22K	22238K	7.4803	200SD22K	22240K	7.8740	200SD32K	23240K	7.8740
140–179 (lower)	220SD22K	22244K	8.6614	220SD22K	22244K	8.6614	220SD32K	23244K	8.6614
180–240 (upper)	220SD22K	22244K	8.6614	240SD22K	22248K	9.4488	240SD32K	23248K	9.4488
180–240 (lower)	240SD22K	22248K	9.4488	260SD22K	22252K	10.2362	260SD32K	23252K	10.2362
				Press felt rolls					
100–139	50SD23	22310	1.9685	60SD23	22312	2.3622	70SD23	22314	2.7559
140–179	60SD23	22312	2.3622	70SD23	22314	2.7559	80SD23	22316	3.1496
180–240	70SD23	22314	2.7559	80SD23	22316	3.1496	90SD23	22318	3.5433
				Smooth, marking and/or size presses					
100–139 (upper)	160SD22K	22232K	6.2992	190SD22K	22238K	7.4803	190SD32K	23238K	7.4803
100–139 (lower)	160SD22K	22232K	6.2992	190SD22K	22238K	7.4803	190SD32K	23238K	7.4803
140–179 (upper)	190SD22K	22238K	7.4803	200SD22K	22240K	7.8740	200SD32K	23240K	7.8740
140–179 (lower)	190SD22K	22238K	7.4803	200SD22K	22240K	7.8740	200SD32K	23240K	7.8740
180–240 (upper)	220SD22K	22244K	8.6614	240SD22K	22248K	9.4488	240SD32K	23248K	9.4488
180–240 (lower)	220SD22K	22244K	8.6614	240SD22K	22248K	9.4488	240SD32K	23248K	9.4488

Certain assumptions had to be made as to roll diameters where not specified in the tables, but the diameters so selected, usually on the low side, were close enough so as not to affect the over-all bearing life expectancy. However, certain load components were followed in the calculations, which components, the author believes, are acceptable to the paper machinery designer, as follows:

(a) Maximum fourdrinier wire and wet and dry felt tensions at 20 p.s.i. width.

One exception to this base figure may be in the

case of endless wool felts now coming into use somewhat in this country for drying thin specialty papers, but with the design work being done on sensitive felt tension controls, it may be found, even in this case, that the above tension figure will apply.

(b) That the following maximum nip pressures apply:

1. Between the couch and cylinder mold—50 pounds per lineal inch.
2. Between the felt squeeze rolls—100 pounds per lineal inch.
3. At the primary presses of cylinder machines—250 pounds per lineal inch.
4. At the main presses of cylinder machines—300 pounds per lineal inch.
5. At the main presses of fourdrinier machines—250 pounds per lineal inch.
6. At the smooth press of fourdrinier machines—200 pounds per lineal inch.
7. At the pressure roll of Yankee machines—500 pounds per lineal inch.

gether of main press roll bearings for both types of machines may be subject to further study, but the grouping is confined only to machine speeds up to 800 f.p.m., regarding which the aforementioned 300 pounds nip pressures for cylinder machines were used for the bearing size calculations. The bearing sizes shown for the other two speed ranges are strictly for the fourdrinier nip pressure of the aforementioned 250 pounds per lineal inch. This means that if the bearing sizes in the grouping "up to 800 f.p.m." are selected for fourdrinier applications, that the user is securing bearing sizes that will give him greater than the predicted average life which should not be objectionable. The main point of such a standardization would allow the builder to consider the same type of framing, same bearing housings, and general design for both cylinder and fourdrinier machines in this low speed category.

Referring to Table III, and only to the 48-inch driers, the bearing sizes could conceivably be shifted from the "22" series to the lighter capacity "30" series. The major reason, however, for suggesting the "22"

Table III. Suggested Standardization of Spherical Roller Bearings for Paper Machines

Drier Section—Both Fourdrinier and Cylinder Machines

Machine width, Fourdrinier wire or mold face, inches	*Up to 800 f.p.m.*			*800 to 1500 f.p.m.*			*1500 to 2000 f.p.m.*		
	AFBMA bearing No.	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*
				Paper and/or felt driers					
100–139									
(48 in. diam.—front)	150SD22K	22230K	5.9055	150SD22K	22230K	5.9055	....	...	..
(48 in. diam.—back)	170SD22K	22234K	6.6929	170SD22K	22234K	6.6929	....	...	..
140–179									
(48 in. diam.—front)	170SD22K	22234K	6.6929	170SD22K	22234K	6.6929	170SD22K	22234K	6.6929
(48 in. diam.—back)	190SD22K	22238K	7.4803	190SD22K	22238K	7.4803	190SD22K	22238K	7.4803
100–139									
(60 in. diam.—front)	150SD22K	22230K	5.9055	170SD22K	22234K	6.6929	170SD22K	22234K	6.6929
(60 in. diam.—back)	170SD22K	22234K	6.6929	190SD22K	22238K	7.4803	190SD22K	22238K	7.4803
140–179									
(60 in. diam.—front)	170SD22K	22234K	6.6929	190SD22K	22238K	7.4803	190SD32K	23238K	7.4803
(60 in. diam.—back)	190SD22K	22238K	7.4803	220SD22K	22244K	8.6614	220SD22K	22244K	8.6614
180–240									
(60 in. diam.—front)	190SD32K	23238K	7.4803	190SD32K	23238K	7.4803	190SD32K	23238K	7.4803
(60 in. diam.—back)	220SD22K	22244K	8.6614	220SD22K	22244K	8.6614	220SD32K	23244K	8.6614
				Drier felt rolls					
100–139	50SD23	22310	1.9685	60SD23	22312	2.3622	70SD23	22314	2.7559
140–179	60SD23	22312	2.3622	70SD23	22314	2.7559	80SD23	22316	3.1496
180–240	70SD23	22314	2.7559	80SD23	22316	3.1496	90SD23	22318	3.5433

Note: Alternate for back bearing 60-inch diam. driers 140 to 240 inches wide, inclusive, is I-112618.

A feature to relate in connection with the bearing sizes shown in Table I, is that the size of the bearings for the wire and press felt rolls is the same as those shown later in Tables II and III for the press felt and drier felt rolls. It will be noted that no bearing sizes are shown for the cylinder machine over 800 f.p.m.

Referring to Table II, it will first be noted that the lower roll of the smooth, marking, and/or size presses is made directly interchangeable with the upper press roll of the main presses. It will also be noted that the upper and lower bearing sizes for the smooth, marking, and/or size presses are identical, not only to permit standardization, but to give the papermaker the opportunity to switch these rolls around if he so desires.

One of the chief facts regarding this table is to note that the roll locations contained in it refer both to fourdrinier and cylinder machines. This grouping to-

series for the 48-inch diameter driers is that it appears practical in these cases to permit the front side bearing to slide in its housing, the controlling factor being the pound per square inch outer race projection in the bearing housing, using a 72° arc by width of bearing at the load zone and concerning which further details will be discussed later in this paper.

As regards the bearing sizes selected for the 60-inch driers, one of the chief problems here is to have as much a continuity of the journal diameters and housing bores and bearing sizes as possible in going from one speed range to the other. It will be noted that identical journal diameters, particularly for the middle and high-speed ranges, have been maintained, by shifting from the "22" series to the "32" series in two cases out of six, and that the same bearing sizes remained in the other four cases. One of the basic concepts here

is that if a builder's framing is divided at say 1500 f.p.m., that it would be possible in going to a heavier framing from 1500 to 2000 f.p.m., that fewer engineering drawing and pattern changes would be required, as far as the bearings are concerned, as the only difference between the "22" and "32" series is in bearing width and, of course, bearing capacities.

As previously mentioned, the bearing size selection for the drier felt rolls is the same as the press felt and the wire rolls.

Table IV, referring to the Yankee drier bearing selection, shows the same size bearing from 140 inch face upward, but for 100 to 139 inches a smaller bearing size is suggested. The pressure rolls, as previously mentioned, are based on calculations using nip pressures of 500 pounds per lineal inch against the face of the Yankee drier.

proper design of the bearing housing to fit an upper press roll arm, then bearing size 120SD23K can be used, which has a bore of 4.7244 inches, an outside diameter of 10.2362 inches, a width of 3.3858 inches, and an approximate rated capacity of 108,900 pounds at 100 r.p.m., satisfying first, of course, that the journal size reduction is permissible.

The chief consideration in making shifts from one series of bearing to another (there being five major series) is that the rated capacities of the bearing sizes so substituted do not vary say beyond plus or minus 5% of the rated capacities of the bearing sizes suggested in the tables.

BEARINGS ON PAPER AND/OR FELT DRIERS

In connection with an analysis of the application of roller bearings to paper and/or felt driers, Table V

Table IV. Suggested Standardization of Spherical Roller Bearings for Paper Machines

For Fourdrinier Machines

Machine width, Fourdrinier wire, inches	*Up to 800 f.p.m.*			*800 to 1500 f.p.m.*			*1500 to 2000 f.p.m.*		
	AFBMA bearing No.	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*	*AFBMA bearing No.*	*Bearing ref. No.*	*Diameter journal, inches*
Yankee driers—12 foot diameter									
100–139 (front)	340SD31K	23168K	13.3858	340SD31K	23168K	13.3858	340SD31K	23168K	13.3858
100–139 (back)	340SD31K	23168K	13.3858	340SD31K	23168K	13.3858	340SD31K	23168K	13.3958
140–179 (front)	420SD31K	23184K	16.5354	420SD31K	23184K	16.5354	420SD31K	23184K	16.5354
140–179 (back)	420SD31K	23184K	16.5354	420SD31K	23184K	16.5354	420SD31K	23184K	16.5354
Pressure rolls									
100–139	200SD32-K	23240K	7.8740	220SD32-K	23244-K	8.6614	240SD32-K	23248-K	9.4488
140–179	240SD32-K	23248K	9.4488	260SD32-K	23252-K	10.2362	280SD32-K	23256-K	11.0236

In conclusion, it may be found in a few cases that in working with the suggested bearing sizes that space limitations and other factors may prevent the use of the size and series of bearing shown in the tables; hence, recourse has to be made to a more suitable bearing size.

Table V. Axial Expansion of Paper and/or Felt Driers

Gage pressure, lb.	*Temperature (approx.), °F.*	*Drier face, inches width* 100	140	180	240	284
		Distance between bearing centers, inches 126	170	214	276	324
50	298	0.187	0.252	0.317	0.408	0.480
75	320	0.204	0.275	0.347	0.447	0.535
100	338	0.218	0.294	0.370	0.477	0.561
150	366	0.242	0.326	0.411	0.530	....
200	388	0.261	0.352	0.433	....	....
...	450	0.311	0.420	....	....	....

For example, under Table II, bearing size 160SD22-K is suggested for the upper main press in the speed range "up to 800 f.p.m." and machine width 100 to 139 inches. This bearing has a bore of 6.2992 inches, an outside diameter of 11.4173 inches, and a width of 3.1496 inches and an approximate rated capacity of 104,800 pounds at 100 r.p.m. Now assuming that the outside diameter is too large to permit

shows the amount of axial expansion of driers as a result of the steam pressures used.

The above calculations for cast-iron driers have been based on a coefficient of expansion of 0.0000065 inch per lineal inch per degree rise (°F.) in temperatures over 70°F. room temperature and for all practical purposes are suitable for steel driers.

As is well established, the drive or back side bearing location of a paper and/or felt drier is the "held" or located bearing, while the front or tending side is the "floating" bearing. There are three general classifications of bearing designs to take care of the requirement for the "floating" bearing to permit the axial movement resulting from drier expansion.

Floating Bearing Design

1. To provide for the movement of the bearing itself within the housing, confining this suggestion to the spherical roller bearing only. This method should also be confined, at least for the present, to those load conditions on the front side bearing that do not exceed approximately 350 p.s.i. pressure on the projected area defined by an area consisting of a 72° arc of the outside of the outer race of a bearing size under consideration by the width of the outer race. The housing bore should be well and carefully machined.

While there are many front side paper and/or felt driers so operating, it would be well that a thorough check-through be made if higher contact pressures are contemplated between the outer race and the housing.

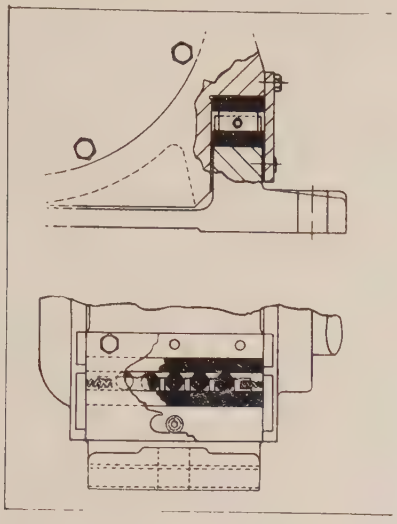

Fig. 4. The ladder bearing-elevation and end sections

2. To allow the rollers in a straight roller bearing (Fig. 1) to move axially along a special width inner race. No foreseeable load limit on paper machine driers applies to this design.

3. To definitely hold from lengthwise movement the front side bearing in its bearing housing and to then adopt such devices as flexible vertical springs or

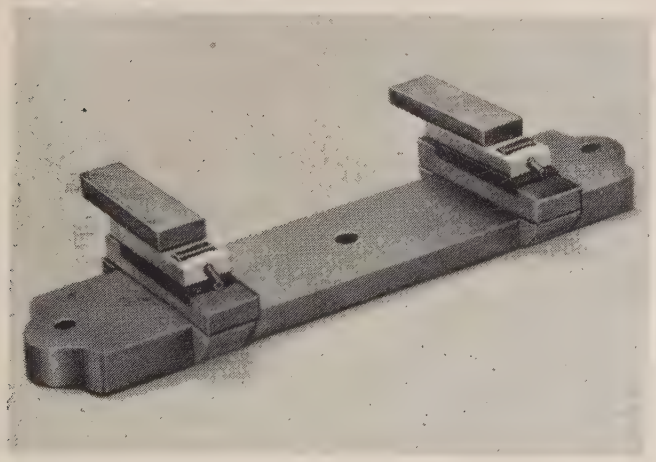

Fig. 5. Complete ladder bearing, mounted on sub-base. Front-side paper drier

the commonly used rocker mounting or the newer ladder type development, all three of which require a sub-base under the bearing housing and also all are interchangeable as to total over-all dimensions and journal center heights.

Figure 4 shows the elevation and end sections of the ladder type method to permit axial expansion of the front side of paper and/or felt driers. It is further illustrated by photograph, Fig. 5.

Figure 6 illustrates the spherical roller bearing mounting with the section shown at the vertical center line. This main bearing mounting is identical to those mountings regarding which the axial movement is secured by the use of a rocker mounting.

The ladder method, called "ladder bearing" consists of two rectangular pieces of hardened bearing steel, between which is positioned a series of short hardened and ground rollers mounted in a bronze cage and held centrally by springs as indicated. There are two complete ladder bearings per housing mounting. The shop work on the housing to accomodate the "ladder bearing" consists only in planing crosswise both corners of it a sufficient amount to permit the installation of the two "ladder bearings" which are mounted directly on the sub-base. End and side plates bolted to the housing keep the bearing in position at all times, and eliptical slots in the end plates permit the main bearing housing to accommodate any magnitude of movement of the paper and/or felt drier.

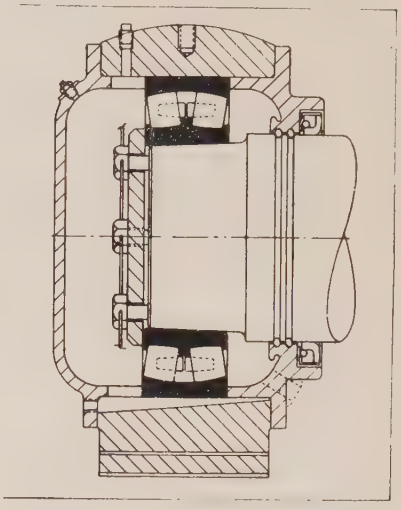

Fig. 6. Spherical bearing section at center. Front-side paper drier

The use of "ladder bearings" while relatively new in use for paper and/or felt driers, has for some years been in successful use on many supercalender front side bottom bearing locations.

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Experiments on Water and Steam Cooking of Aspen

J. N. McGOVERN, K. J. BROWN, and W. A. KRASKE

Aspen (*Populus tremuloides*) chips were subjected to water and steam cooking and oven heating before fiberizing the treated chips mechanically at atmospheric pressure to produce pulps in the yield range of 72 to 96%. Variables of time, temperature, ratio of water to wood, and wood moisture were studied. For water cooking, the following results were obtained: (1) pulp yield decreased in an orderly way with increasing temperature from 150 to 180°C. and increasing time from 0 to 60 minutes; (2) the rate of pulping as measured by pulp and lignin yields was rapid to a yield of nearly 75% and then was slow; (3) decreasing the ration of water to wood from 6 to 2 resulted in decreased pulping time for the same yield; (4) maximums in strength properties were shown at yields of 80 to 85% independent of pulping conditions; and (5) lignin and carbohydrate matter were removed in nearly constant down-to-pulp yields of nearly 75%. For steam cooking, the relations of yield to time and temperature of pulping, pulp composition, and pulp strength were closely the same as for water cooking. Oven heating of chips at temperatures of 170 to 200°C. in the absence of water degraded the pulps so that their strengths were below those from untreated wood and caused a conversion of carbohydrates into ligninlike material proportional to the severity of the treatment. Pulps produced in yields of 81 and 84% by water and steam cooking, respectively, were made into corrugating boards that had strength properties equaling or approaching those of commercial hardwood semichemical corrugating board and that corrugated satisfactorily.

Efforts have been made since the earliest days of wood pulping to produce pulps for papers and boards by treating wood chips with steam or water at elevated temperatures and then mechanically fiberizing the treated chips. Rue (*9*) reported that it was discovered in 1869 that intercellular material in wood was dissolved by water alone at elevated temperatures to permit chips to be readily fiberized. Porphyre recently (*8*) mentioned a patent (*5*) issued the same year for pulping wood with water. Since this early date there have been several eminently successful commercial applications of the pulping of wood chips with steam or water, especially for pulps used in wallboard and saturating felt. The Masonite and Asplund processes are outstanding examples of these applications, and there are others (*1, 2, 12*).

The purpose of steam or water cooking is the same as that of any pulping process, namely, to break, weaken, soften, or otherwise alter or destroy the bond between the fibers in wood to permit their more or less ready separation. Steam or water cooking differs from chemical pulping, however, mainly in the objective of obtaining pulps in yields as near to 100% as possible with minimum loss of cellular and intercellular material. Important objectives of research in water and steam cooking are to obtain pulps having wider use than common for coarse fibers and to improve the procedures for making the pulps.

Although the commercial application of steam and water cooking is well established, there does not appear to be available as complete information on the variables of the cooking process as desirable. The literature on the subject does contain, however, certain information on the effect of the conditions of water and steam on pulp yield and chemical composition, and certain articles are referred to as follows: Aronovsky and Gortner (*3*) studied the cooking of aspen sawdust in water at temperatures varying from 100 to 186°C. and over intervals of 2 to 12 hours. Water was found to be an active reagent in the cooking of wood and caused a certain solution of lignin although it could not be classed as a pulping agent from the standpoint of removal of the incrustant and cementing materials present in wood. Heritage and Duvall (*7*) reported on the steam cooking of aspen chips and the production of whole fibers from them. They found that there was a critical temperature that must not be exceeded if substantial gasification from the depolymerization of wood is to be avoided. This temperature varied with species, time, and other conditions, and was, in the case of aspen, at a temperature corresponding to steam pressures of 175 and 200 p.s.i. for 4 and 2 minutes, respectively. Schwartz and coworkers (*11*) described a steam-cooking process for producing pulps for insulating boards and hardboards from certain sawmill and logging wastes.

Various aspects of the action of water on wood have been studied from the basis of wood chemistry including the hydrolysis and saccharification of wood in the presence of acids. The results of most of these studies are not quite pertinent to the present report. Of interest, however, is the work of Hawley and co-workers (*6*) who reported that the heating of wood at an elevated temperature caused a conversion of wood carbohydrates into ligninlike material. Saeman (*10*) showed that hydrolysis of hemicelluloses in wood took place readily under treatment with dilute acid at high temperature.

The purpose of the present experiments was to provide additional information on the effect of the variables of time, temperature, wood-to-water ratio, and moisture content in treating wood chips on the properties of pulps made from the chips, especially in terms of the paper- and boardmaking characteristics of the pulps. The pulping process used was basically a batchwise treatment of the chips followed by atmospheric attrition. Other steam- or water-cooking procedures, such as continuous treatment followed by

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attrition under atmospheric or elevated pressures, would, of course, have been possible for use (*7*).

EXPERIMENTAL PART

The aspen (*Populus tremuloides*) used in these experiments was cut in Wisconsin. The wood was stored approximately 6 months before use and had a moisture content of 20 to 25%. The wood was made into standard $^5/_8$-inch chips for the experiments.

The water- and steam-cooking experiments were conducted mainly in a stainless-steel, steam-jacketed, tumbling autoclave with a capacity of 0.8 cubic foot. One steam and one water digestion were also made in a stainless-steel-lined, steam-jacketed, tumbling digester with a capacity of 13 cubic feet. A forced-air oven was used for the oven-heating experiments in the absence of water.

The autoclave-cooked chips were fiberized either in a 5-pound experimental beater with $^5/_{16}$-inch bronze bars in roll and bedplate or in an 8-inch-diameter, single-rotating-disk attrition mill. The oven-heated chips were fiberized in the 8-inch attrition mill. The digester-cooked chips were fiberized in a 36-inch-diameter, double-rotating-disk attrition mill.

Table I. Conditions and Results of Water- and Steam-Cooking Experiments on Aspen Chips

	Cooking conditions						
		Cooking Time					
Cook No.	*Temperature, °C.*	*Nominal, min.*	*Corrected,[a] min.*	*Equivalent at 180°C.[a] min.*	*Pulp yield, %*	*Pulp lignin content, %*	*Pulp brightness, %*
Water Cooking with Indirect Steam							
554	180	60	63.4	63.4	71.7	13.5	14.8
566	180	60	58.0	58.0	70.0	13.9	14.6
577	180	45	46.3	46.3	73.3	15.5	....
555	180	10	14.7	14.7	75.2	16.0	18.5
560	180	0	4.7	4.7	81.4	16.5	23.1
540	170	60	64.1	21.4	73.9	16.8	16.3
545	170	45	51.7	17.2	75.0	17.0	13.9
541	170	30	32.6	10.9	77.9	16.9	17.0
544	170	15	20.3	6.8	80.2	16.9	18.6
550	170	10	12.2	4.1	80.6	16.4	20.1
575	170	7	11.1	3.7	86.4	16.2	26.7
556	170	0	5.7	1.9	88.0	15.8	....
549	160	60	63.0	7.0	80.7	17.3	15.8
576	160	27	30.8	3.4	87.0	16.0	27.4
548	160	10	13.6	1.5	91.8	16.9	30.1
557	160	10	15.2	1.7	88.9	16.2	29.5
547	150	60	60.0	2.2	87.1	16.2	25.3
546	150	10	10.0	0.4	96.1	16.2	....
Steam Cooking							
563	170	60	61.2	20.4	73.4	15.5	16.2
564	170	10	11.6	3.9	85.6	16.3	26.4
565	160	60	61.2	6.8	78.4	17.1	17.2
567	160	10	11.7	1.3	93.4	16.6	33.9
578	150	60	60.0	2.2	90.9	16.8	31.2
568	150	10	10.0	0.4	95.3	16.7	....

[a] See text.

The digester-made pulps were converted into corrugating board on an experimental, 12-inch fourdrinier paper machine.

The time-temperature series of water digestions was conducted with a water-to-wood ratio of 6 to 1. Indirect heating was used, allowing 45 minutes to reach the cooking temperature. The fiberizing was done in the beater under standard conditions of a hot-water soak (40°C.) and a definite roll-pressure schedule. The pulp yields were determined on the basis of the fiberized pulps. The pulps were tested for strength in an Appleton test beater by TAPPI standard methods, using a 55-pound test sheet. The pulps were also analyzed for lignin content and tested for brightness by standard methods. The digestion conditions and yield, lignin, brightness, and strength data are given in Tables I and II. The pulps were also screen-fractionated, and the data are given in Table II. Calculations were made of the effect of temperature during the rise period, and corrections were accordingly applied to the nominal digestion times.* The corrected digestion times were also converted into equivalent digestion times at 180°C. These data are given in Table I.

The time-temperature series of steam digestions was conducted with direction steam heating. The cooking temperature was reached in 20 minutes. The condensate was removed continuously through an automatic steam trap. The digestion conditions and pulp properties are also given in Tables I and II the screen-fractionation data in Table II and the corrected and equivalent digestion times in Table I.

The experiments on effect of ratio of water to wood were made with chips having a moisture content of 60%. The original chips with a moisture content of approximately 20% were evacuated and pressure-treated in water to raise the moisture content to 60%. The following ratios of water to wood, including the water in the wood, were employed: 2, 3, and 6 to 1. The digestions were made in the tumbling autoclave, using indirect steam heating. The cooking temperature of 170°C. was reached in 45 minutes. The cooking times at 170°C. were 0, 7, and 15 minutes for each water-wood ratio. The pH values of the spent liquors were determined. The water-cooked chips were fiberized in the 8-inch attrition mill, and the yields were determined from the fiberized pulps. The pulps were tested for strength and analyzed for chemical composition. The strength-test sheets were made to a 115-pound weight since the low strength values of some of the pulps gave very low instrument readings with the 55-pound sheets. The digestion conditions and test results are given in Tables III and IV.

The steam and water cooks in the 13-cubic-foot digester were made as follows: the chips were presteamed at atmospheric pressure for 1 hour for both digestions. For the water cook, a water-to-wood ratio of 5 to 1 was employed and the temperature was raised to 170°C. in 53 minutes and held there for 7 minutes. For the steam cook the chips were raised from 90°C. (after presteaming) to 170°C. in 24 minutes and held there 10 minutes. The yields were determined on a fiberized-pulp basis from aliquot portions of chips fiberized in the 8-inch attrition mill. The fiberizing conditions were such as to give pulps with freeness

* The corrections of the nominal cooking times for cooking action during the rise to the cooking temperature were made according to the equations developed by Calhoun, Yorston, and Mass (*4*), with the exception of using a temperature coefficient of 3 instead of 2 as used by these workers. The yield-time data within the range of the experiments indicated that a temperature coefficient higher than that of 2 often encountered with organic chemical reactions was in force, so the value of approximately 3 found by Saeman (*10*) for acid hydrolysis of Douglas-fir wood was used. The present data were too few and the cooking reactions too complicated for an analysis of the data from the standpoint of kinetics.

values (Canadian Standard) near 600 ml. The pulps were made directly into corrugating board on the 12-inch experimental paper machine without beating or jordaning or without added materials. The freeness of the stock at the headbox was 470 ml. The mill. The pulps were tested as indicated previously. The results are given in Table VII. Untreated aspen chips were also fiberized in the 8-inch attrition mill and were tested. These results are likewise given in Table VII.

Table II. Results of Water- and Steam-Cooking Experiments on Aspen Chips

Cook No.	Cooking temperature, °C.	Pulp yield, %	Nominal cooking time, min.	Strength properties[a] at 0.55 g. per cc. density: Bursting strength, points per lb.	Tearing strength, g. per lb.	Tensile strength, meters	Schopper-Riegler freeness, ml.	Screen analyses: On 24 mesh, %	Through 150 mesh, %
Water Cooking with Indirect Steam									
554	180	71.7	60	0.12	0.30	1200	625	16.7	30.3
566	180	70.0	60	0.13	0.29	1350	620	18.7	16.9
577	180	73.3	45	0.17	0.27	1850	640	33.2	16.2
555	180	75.2	10	0.25	0.51	2200	700	36.5	16.4
560	180	81.4	0	0.32	0.72	3000	680	54.9	13.6
540	170	73.9	60	0.21	0.37	2100	520	44.2	13.0
545	170	75.0	45	0.24	0.53	2250	540	46.5	14.6
541	170	77.9	30	0.31	0.67	2700	635	43.7	14.8
544	170	80.2	15	0.33	0.70	2750	630	48.2	10.6
550	170	80.6	10	0.30	0.73	2750	725	59.8	11.4
575	170	86.4	7	0.32	0.75	2700	660	64.0	9.2
556	170	88.0	0	0.34	0.62	2750	570	55.3	8.8
549	160	80.7	60	0.25	0.52	2350	650	54.9	14.3
576	160	87.0	27	0.28	0.68	2600	680	59.1	11.8
548	160	91.8	10	0.28	0.42	2600	490	62.4	13.4
557	160	88.9	10	0.31	0.51	2775	460	69.3	5.9
547	150	87.1	60	0.28	0.58	2350	640	61.2	14.3
546	150	96.1	10	0.17	0.38	1300	510	79.0	5.6
Steam Cooking									
563	170	73.4	60	0.17	0.43	1600	510	30.0	15.8
564	170	85.6	10	0.25	0.63	2650	600	48.9	10.8
565	160	78.4	60	0.24	0.55	2150	600	50.6	11.4
567	160	93.4	10	0.26	0.58	2600	450	67.6	5.2
578	150	90.9	60	0.26	0.55	2850	540	70.4	7.9
568	150	95.3	10	0.18	0.42	1800	475	77.5	1.9

[a] 25 × 40—500 ream.

pulps and boards were tested for strength and the results are given in Tables V and VI, respectively. Samples of the water- and steam-cooked boards approximately 24 inches in length were corrugated on a small commercial-type corrugator.

EFFECT OF TIME AND TEMPERATURE IN WATER AND STEAM COOKING

Water Cooking

The results of the experiments on water cooking given in Tables I and II indicated that water at

Table III. Results of Aspen Water-Cooking Experiments with Different Water-Wood Ratios

Cook No.	Cooking conditions[a]: Ratio of water to wood	Time at 170°C. min.	pH of spent liquor	Pulp yield, %	Chemical analyses of pulps: Lignin, %	Holocellulose, %	Alphacellulose %	Strength properties[b] at 0.55 g. per cc. density: Bursting strength, points per lb.	Tearing strength, g. per lb.	Tensile strength, meters	Schopper-Riegler freeness ml.
677	2	0	3.95	90.1	17.7	83.2	52.0	0.32	0.65	2400	680
676	2	7	3.77	86.0	17.3	78.2	55.7	0.34	0.72	2850	730
675	2	15	3.64	81.7	17.7	74.4	56.0	0.29	0 70	2250	740
673	3	0	4.09	92.2	17.0	82.6	51.4	0.31	0.58	2400	600
672	3	7	3.89	85.7	17.1	80.5	55.5	0.31	0.72	2450	710
671	3	15	3.67	82.6	17.0	79.4	58.7	0.30	0.82	2000	750
674	6	0	4.38	93.1	17.1	84.5	53.2	0.28	0.61	2500	680
678	6	7	4.19	89.5	17.6	80.7	53.8	0.32	0.65	2200	730
663	6	15	3.94	81.3	16.8	76.2	58.4	0.30	0.90	2500	790

[a] Forty-five minutes from room temperature to 170°C.
[b] 25 × 40—500 ream.

The oven-heating experiments were conducted by heating chips contained in a wire basket in the forced-air oven. The chips had a moisture content of 15%. The chips were heated for periods of 35 and 75 minutes at temperatures of 170, 180, 190, and 200°C. The chips were placed in the oven at 135°C., and the treating temperature was reached in 15 to 20 minutes. The treated chips were fiberized in the 8-inch attrition elevated temperatures had a definite action on the wood. The conditions of time and temperature employed were found to affect greatly the yields and properties of the pulps, as shown below.

Pulp Yields. The relations between pulp yield and time and temperature of water cooking are shown in Figs. 1 and 2. These figures show that there was little action in a short time at 150°C., not much more

than that accompanying fiberizing at low temperatures since the yield was near that of fiberized raw wood or groundwood pulp. The pressure in the autoclave, however, was slightly above that of the steam. This indicated that wood decomposition had started. At temperatures above 150°C. there was considerable loss of material in short digestion periods. The loss was presumably mainly due to acid hydrolysis, the acids being organic acids, such as acetic acid, formed from acetyl groups in wood. The spent liquor had a pH value near 4. For example, a loss of nearly 20% occurred during the temperature-rise period to 180°C., with the major portion being above 150°C. Appreciable loss was encountered at 150°C., however, after

Table IV. Relations Between pH Values of Spent Liquor and Water-Wood Ratio Versus Cooking Time and Pulp Yield in Aspen Water Cooking

pH Values of spent liquor	*Ratio of water to wood*	*Cooking time[a], min.*	*Pulp yield, %*
3.8	2	11.8	86.4
3.8	3	15.5	84.3
3.8	6	(*b*)	(*b*)
4.0	2	2.0	91.5
4.0	3	8.3	89.6
4.0	6	18.1	83.3
4.2	2	(*b*)	(*b*)
4.2	3	1.3	94.0
4.2	6	11.3	88.7

[a] Includes 5 minutes correction for cooking during temperature-rise period.
[b] Outside range of experiments.

1 hour of digestion, and a very considerable loss in the same time at 180°C. The temperature-yield relation (Fig. 2) showed roughly a slightly greater yield loss with increasing temperature above 170°C., which indicated that a part of the wood was fairly easily hydrolyzed and another portion fairly resistant.

Table V. Comparison of Aspen Water- and Steam-Cooked Pulps Made on Small and Large Scales

Cook No.	*Cooking medium*	*Pulp yield, %*	*Strength properties at 0.63 g. per cc. density: Bursting strength, points per lb.*	*Tearing strength, g. per lb.*
	Autoclave Digestions			
544–50	Water	80.4	0.39	0.67
575	Water	86.4	0.40	0.75
	Semicommercial Digestions			
5411	Water	81.0	0.33	0.77
5415	Steam	83.9	0.39	0.85

The pressure in excess of that of the steam increased with increase in treating temperature. The excess pressures were 6, 9, 12, and 20 p.s.i. for temperatures of 150, 160, 170, and 180°C. There was no evidence of increasing pressure with time at a given temperature.

The conversion of the cooking times at the various temperatures to equivalent times at one temperature, 180°C. (Table I), gave a picture of the yield-time relation over a wider range of yields than was possible at any one temperature (Fig. 3). The yield appeared to approach a minimum value within the range of the experiments. A plot of the logarithms of the yields against equivalent pulping times also showed this trend (Fig. 4). The slope of this curve at any time is proportional to the rate of cooking. The rapid rate at the start of the reaction and the slow rate at the longer times indicated, as mentioned previously, that certain portions were readily hydrolyzed, but that

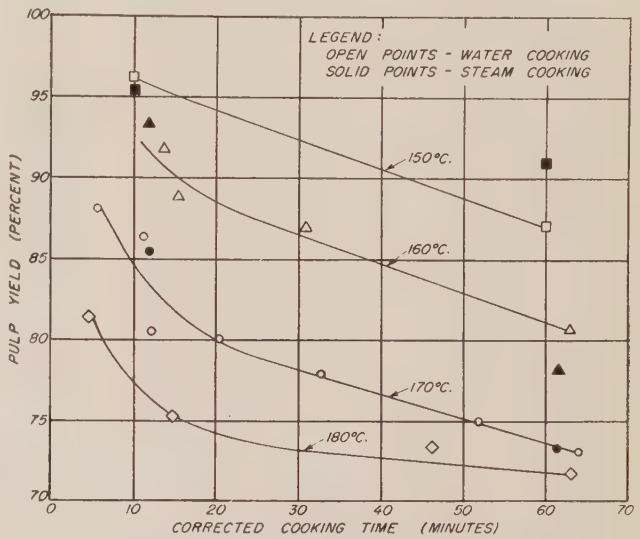


Fig. 1. Relations between aspen pulp yield and time of cooking with water and steam at several temperatures

the major portion of the wood was quite resistant under the conditions of the experiments. Hemicelluloses were probably not resistant and were removed. The data for all the temperatures fitted this curve reasonably well.

Table VI. Properties of Experimental Aspen Water- and Steam-Cooked and Commercial Semichemical Corrugating Boards

Properties	*Pulping processes: Water cook*	*Steam cook*	*Neutral sulphite semichemical*	
Species	*Aspen*	*Aspen*	*Chestnut*	*Southern hardwood*
Pulp yield., %	81.0	83.9	...	...
Machine-run number	3016	3032	2786[a]	2785[a]
Headbox freeness (Canadian Standard), ml.	470	465	...	...
Properties of corrugating board:				
Weight, lb. per 1000 sq. ft.	25.80	25.70	27.60	26.60
Caliper, 0.001 in.	7.90	9.10	8.50	9.80
Density, g. per cc.	...	...	0.63	0.52
Bursting strength:				
Mullen, pt.	27.50	28.60	28.00	32.00
Unit, pt. per lb.[b]	0.31	0.32	0.29	0.34
Tearing strength, g. per lb.[b]	0.86	0.84	0.81	1.33
Tensile strength, lb. per in. width	24.20	28.70	24.30	33.70
Stretch, %	...	...	1.60	1.90
Folding endurance, double folds	9	8	15	36
Compression resistance, lb.	9.50	10.70	12.90	12.90

[a] Shipment number.
[b] 25 × 40—500 ream.

Lignin Content. The lignin contents of the different water-cooked pulps varied from 13.5 to 17.0%, with most of them being between 16 and 17% or roughly of the same order as that of the wood, 16.5%. The relation between lignin yield and equivalent cook-

ing time at 180°C. was closely the same as the pulp yield-time relation up to the time corresponding to 75% pulp yield (Figs. 3 and 5). With longer times the lignin yields were lower than the pulp yields. This indicated that the rates of hydrolysis and solution of lignin and of carbohydrate material were roughly the same down to yields of 75%, but below this yield there was apparently a greater solution of lignin than carbohydrate material within the range of the experiments. These data thus showed that a portion of the lignin was made soluble under the conditions of acid hydrolysis. The possibility of such a solubility was mentioned previously.

Pulp Strength. When the strength values of the pulps made at the several temperatures were plotted against the respective yield values, definite maximums were shown at yields of nearly 85% (Table II and Fig. 6). The strength properties appeared to be independent of temperature. The tendency toward maximums may have indicated that there was a favorable balance between the effects of mechanical forces used in fiberizing and of the chemical changes in the hydrolysis reaction. The lowest strengths were obtained under the severest and the mildest conditions of hydrolysis giving the lowest and highest yields. Microscopic examination of the lowest-yield pulps showed a large proportion of collapsed fibers and fiber bundles broken cleanly at right angles to the fiber direction. This indicated that the fibers had become embrittled. The chips cooked to the lowest yield at 180°C. were definitely friable. The partially cooked chips made under the mildest conditions of relatively short times and low temperatures were hard and were difficult to fiberize. The pulps contained mechanically damaged fibers and a large proportion of fiber bundles, and were similar to groundwood pulps. The chips treated at 150°C. had, also, dry centers, an indication that penetration was not complete.

Table VII. Conditions and Results of Oven-Heating Experiments on Aspen Wood

Cook No.	Treating conditions Temperature, °C.	Time, min.	Yield, %	Chemical analyses of pulps Lignin content, %	Holocellulose content, %	Yields on raw-wood basis Pulp, %	Lignin, %	Holocellulose, %	Pulp strengths[a] at density of 0.35 g. per cc. Burst, points per lb.	Tear, g. per lb.	Tensile, meters
				Raw Wood							
	...	...	95.3	17.7	82.5	100.0	17.7	82.5	0.072	0.30	660
				Chips with 15% Moisture Content							
621	170	35	95.3	18.5	81.2	100.0	18.5	81.2	0.066	0.29	840
616	180	35	93.9	19.1	80.8	98.7	18.8	79.8	0.078	0.14	800
615	190	35	94.2	19.3	80.8	99.0	19.1	80.0	0.056	0.12	470
612	200	35	94.5	21.7	77.0	99.2	21.5	76.3	0.044	0.22	430
608	170	75	94.6	19.1	80.3	99.3	19.0	79.8	0.080	0.38	800
614	180	75	95.2	20.1	78.1	99.9	20.1	78.0	0.052	0.28	470
617	190	75	93.3	22.8	76.3	98.0	22.3	74.8	0.034	0.08	270
613	196	75	88.5	25.0	73.1	93.0	23.2	68.0	0.030	0.08	150
				Chips with 60% Moisture Content							
623	170	35	...	...	...	...	...	...	0.092	0.41	890

[a] 25 × 40—500 ream.

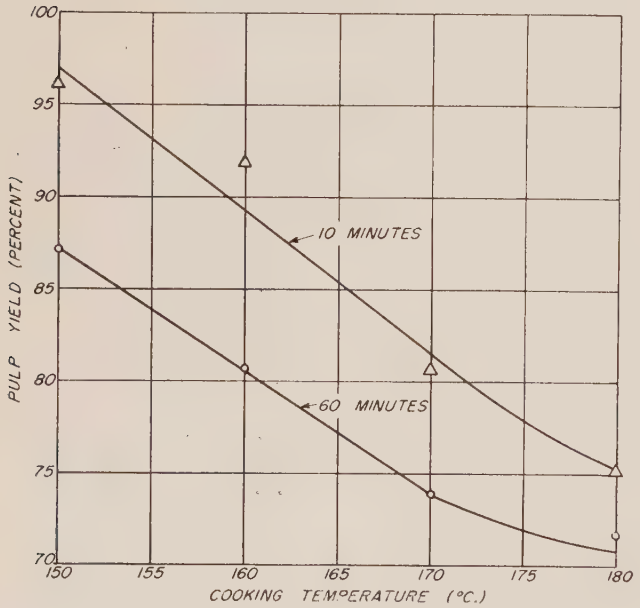


Fig. 2. Relations between aspen pulp yield and temperature of water for nominal cooking times of 10 and 60 minutes

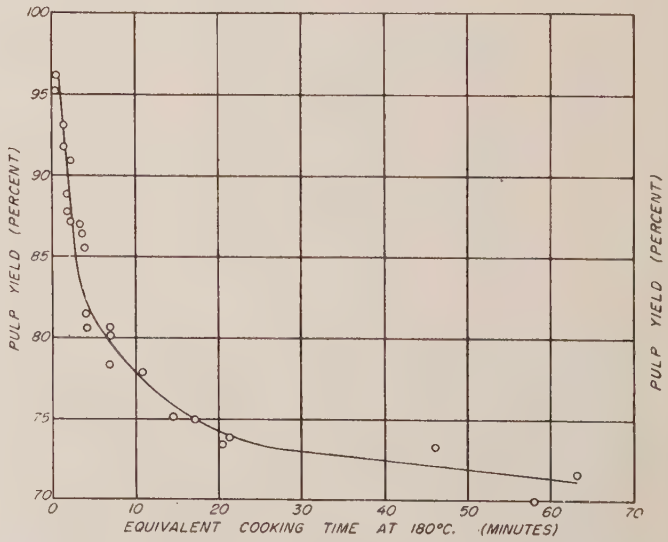


Fig. 3. Relation between aspen pulp yield and equivalent cooking time at 180°C. for water and steam cooking at 150, 160, 170, and 180°C. (Water-wood ratio of 6 in water cooking)

The pulps made in yields of 80 to 85% were made under the most favorable conditions where hydrolysis had affected or removed binding material to permit their fairly ready separation mechanically with least embrittlement.

The pulps were found to increase in strength on beating in a test beater. The bursting strength increased fivefold and the tearing strength twofold in beating from an initial freeness value of nearly 900 to 500 ml.

The pulps made with maximum strengths fell in the range of pulps for corrugating board from a strength standpoint.

Screen Analysis. The percentage of fibers retained on a 24-mesh screen increased, and that passing a 150-mesh screen decreased practically linearly with increasing yield (Table II). Intermediate fractions retained on 42-, 80-, and 150-mesh screens decreased with increasing yield. The trends were independent of temperature of cooking. Since the fiberizing conditions were constant for all the pulps, the trends demonstrated the increase in ease of fiberizing the chips with decreasing yields. There was no indication of a relation between pulp strength and screen analysis.

Brightness. Pulp brightness decreased directly with decreasing yield (Table I). The increased loss in brightness was probably due to the increasing intensity

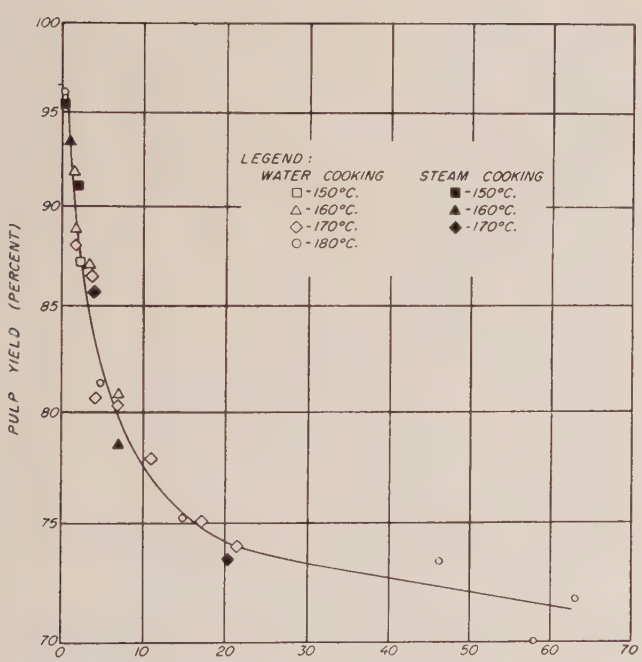


Fig. 4. Relation between logarithm of aspen pulp yield and time of cooking with water and steam at several temperatures

of the acid hydrolysis to which the wood chips were subjected with increasing temperatures and times.

Steam Cooking

Treating of wood at elevated temperatures with steam also affected the properties of pulps made by fiberizing the treated chips. Both the time and temperature of the treatment again affected pulp yield and properties (Tables I and II). Steam would probably be preferred over water for a commercial pulping operation.

Pulp Yields. The yields of pulps made by steam cooking showed the same trends with time and tem-

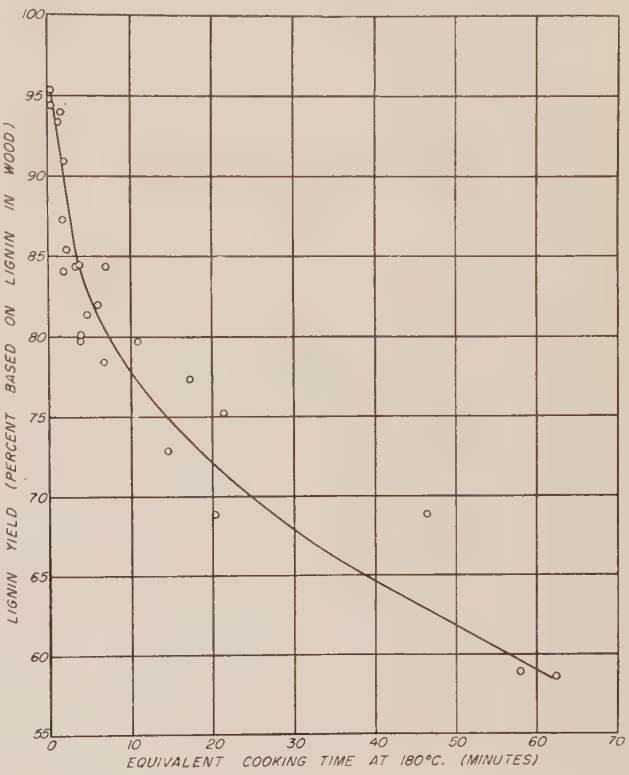


Fig. 5. Relation between lignin yield and equivalent cooking time at 180°C. for water and steam cooking at 150, 160, 170, and 180°C.

perature as those found for water cooking (Table I and Figs. 1 and 3). The rates of pulping with water and steam were also the same (Fig. 4). Apparently the chips rapidly became saturated with moisture in the presence of the steam and maintained this saturated condition. The condensate had the pH value of approximately 4, or in the same range as the spent liquor from water cooking.

Lignin Content. The lignin contents of the steam-cooked pulps fell in the narrow range of 15.5 to 17.1% for pulp yields varying from 73.4 to 95.3% (Table I). The lignin contents were again nearly that of the original wood and gave the same relation with pulping time as found in water cooking (Fig. 5).

Pulp Strength. The bursting, tearing, and tensile strengths of the steam-cooked pulps showed maximums at yields of nearly 85% (Table II and Fig. 6). The data for the steam-cooked pulps fitted the curves for water-cooked pulps reasonably well.

Screen Analysis. The screen-analysis data for the steam-cooked pulps followed the same trends with yield as discussed previously for the water-cooked pulps (Table II).

Pulp Brightness. The pulp brightness data also followed the same trend of decreasing values with

decreasing yield and increasing hydrolysis observed in the water-cooked pulps (Table I).

EFFECT OF RATIO OF WATER TO WOOD IN WATER COOKING

The ratio of water to wood had a definite effect on the conditions and rate of cooking in the water cooking of aspen chips. The water-wood ratio, however,

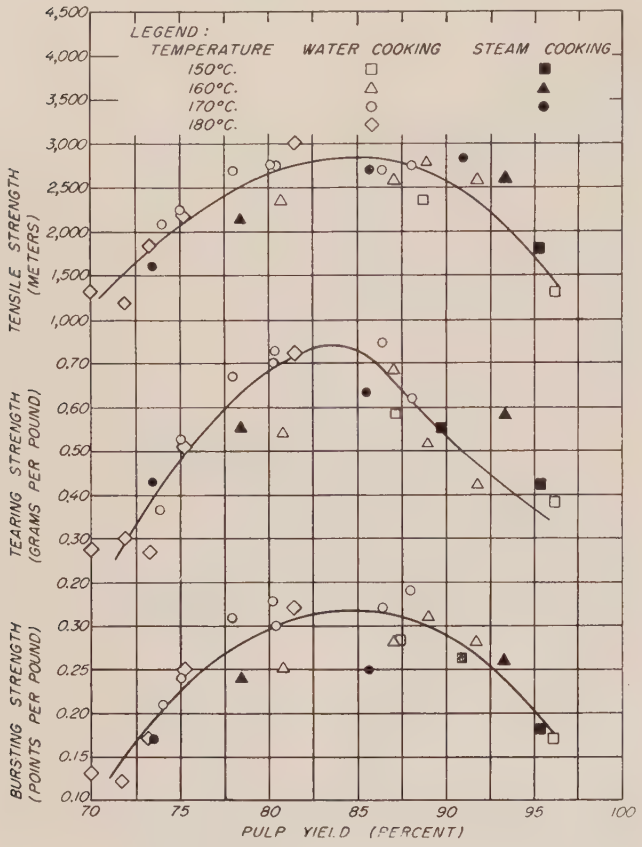


Fig. 6. Relation between pulp strength and yield of aspen pulp from water and steam cooking at several temperatures. (Comparisons made on basis of test sheets with density of 0.55 g. per cc.)

had little effect on pulp properties at a given pulp yield. The data illustrating these points are found in Table III.

Pulp Yield and pH Values

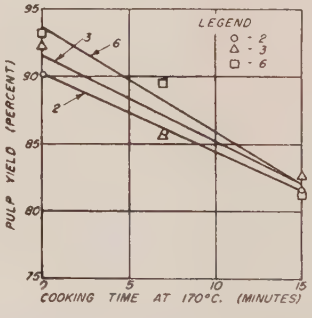
The effect of water-wood ratio on the pulping was shown when families of curves corresponding to the different ratios were obtained by plotting pulp yields and the pH values of the spent liquors against pulping time (Figs. 7 and 8). Although the data were too meager to establish precise relationships between pulp yield, pH values, and cooking time, certain trends were observed. For example, pulp yields and, to a small extent, pH values were found to decrease both with increasing cooking time at a constant water-wood ratio and with decreasing water-wood ratio at constant cooking time. The pH values decreased (and the hydrogen-ion concentration increased) with increasing time because of the increase in acidic-decomposition products. The pH values decreased with decreasing water-wood ratios because of the increase in acid concentration. Pulp yield also decreased with increasing time because of increasing decomposition and solution of both lignin and carbohydrate material, as discussed later. Pulp yield decreased with decreasing water-wood ratio presumably because of the increase in rate of pulping with increase in hydrogen-ion concentration. Although pulp yield decreased with decreasing pH value, the effect did not appear to be independent of water-wood ratio, as might be expected.

Because of the influence of both cooking time and water-wood ratio on the pH values, a given pH value in the intermediate range of the experiments resulted from cooking (a) to a high yield in a short time with a low water-wood ratio, (b) to a low yield in a long time with a high water-wood ratio, or (c) with intermediate conditions (Table IV). This means that both water-wood ratio and pH values need to be controlled in water cooking to obtain the desired result. It is pointed out that the changes in pH values are relatively small over a relatively wide yield range and that pH values are also probably influenced by the buffering action of salts in the wood (ash content) and in the water.

The yield-time relations at the highest ratio of 6 to 1 agreed in trend with those shown previously in the temperature series for the same ratio and temperature. The actual values agreed only approximately, however, apparently because of a difference in chip moisture content, as discussed later.

Lignin, Holocellulose, and Alpha-Cellulose

The lignin values of all the pulps were approximately the same as that of the original wood and were independent of cooking time or water-wood ratio (Table III). This meant that lignin was dissolved at the same rate as the total wood material within the range of these experiments. The relations between lignin yield and cooking time followed closely the pulp-yield relations discussed previously in this series and the lignin-time relations in the temperature series.



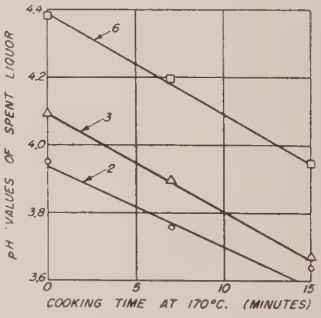


Fig. 7. Relations between aspen pulp yield and time of cooking with water at water-wood ratios of 2, 3, and 6 to 1

Fig. 8. Relations between pH values and time of cooking with water at water-wood ratios of 2, 3, and 6 to 1

The holocellulose values of the pulps decreased with increasing cooking time and with increasing yield (Table III). The trends appeared to be independent of the water-wood ratio. At the highest yields the holocellulose percentages were approximately the same

as that of the wood, and the sum of the lignin and holocellulose losses equaled the yield loss. At the lowest yield the holocellulose percentages were lower than those of the wood, and the sum of the lignin and holocellulose losses exceeded the yield loss. This may have meant that at the lowest yields there was present in the pulp carbohydrate material not analyzing as holocellulose.

The alpha-cellulose contents of the pulps increased with increasing pulping time and with decreasing pulp yield (Table III). The trends were again independent of water-wood ratio. The alpha-cellulose yield (alpha-cellulose content multiplied by pulp yield), however, remained approximately constant in the range of the experiments.

Pulp Strength

The pulp strengths varied slightly with yield, but were independent of water-wood ratio (Table III and Fig. 9). The bursting, tearing, and tensile strengths showed a tendency toward maximums in yields near 85%. This trend and the absolute values checked with those found previously in the temperature series (Fig. 6). The tensile-strength values were lower than those found in the temperature series, possibly because of the different test-sheet weights used in the two series.

Low Water-Wood Ratios

Experiments with a water-wood ratio of 1.2 to 1, or no free water with chips having a moisture content of 60%, were not successful using indirect steam heating because poor heat conduction made it impossible to reach the cooking temperature of 170°C. in a reasonable time. Further, the chips touching the heating surface were darkened by the high temperature at this point.

EFFECT OF MOISTURE CONTENT IN WATER COOKING

A few water-cooking experiments were made with aspen chips having a moisture content of 12%. The chips were thus substantially air-dry and well below the fiber saturation point in moisture. Water-wood ratios of 3 and 2 to 1 were employed. In comparison to the digestions made to the same yield with the moist chips (Table III), those made with the dry chips required a shorter pulping time. In the yield range of 80 to 85% the average cooking times at 170°C. were 14 and 6 minutes. The properties of the pulps made in the same yields from the dry and moist chips were not appreciablly different. The effect of the moisture content of wood chips on their pulping by water- or steam-cooking processes is in need of further investigation.

SEMICOMMERCIAL WATER AND STEAM COOKING AND CORRUGATING BOARDS FROM THE PULPS

The small-scale experiments on water and steam cooking were extended to a larger scale by producing pulps in a semicommercial digester. The pulping conditions were selected to give pulps in yields of 80 to 85% or in the range of optimum strength as determined in the small-scale experiments. Corrugating board was chosen as the end product because the pulp strengths were at the level associated with pulps used for this product.

The pulps obtained by water and steam cooking on the semicommercial scale were made in the desired yield range. The strengths of these pulps were approximately the same as those obtained with the small-scale pulps made in the same yield except for a somewhat low bursting strength for the large-scale, steam-cooked pulp (Table V).

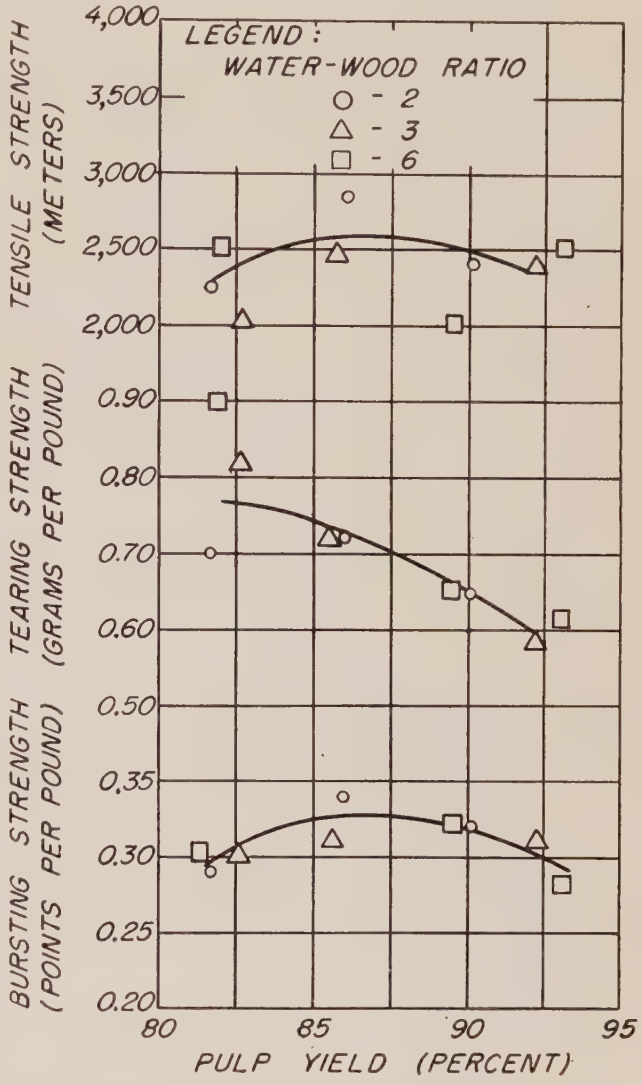


Fig. 9. Relations between pulp strength and yield of aspen pulp made by cooking with water at several water-wood ratios. (Comparisons made on basis of test sheets with density of 0.55 g. per cc.)

The water- and steam-cooked chips were readily fiberized in a single pass through the commercial-size attrition mill to give pulps in the freeness range of corrugating pulps. The energy consumption was 15 hp. days per ton (air-dry). This is a low energy consumption for pulps produced in yields of more than 80%.

The making of corrugating board presented no difficulties, and the two corrugating boards fell within the commercial weight range (Table VI). The cor-

rugating boards from the water and steam cooks had closely equal strength properties, and both were close to commercial hardwood semichemical corrugating board tested at the Forest Products Laboratory, with a few exceptions (Table VI). The experimental boards were appreciably lower in tearing and tensile strengths than the southern hardwood board, but were equal to the chestnut board in these properties. Both boards were somewhat lower in folding endurance and compressive resistance than both commercial boards. The relatively low folding endurance of the experimental boards may indicate a certain brittleness.

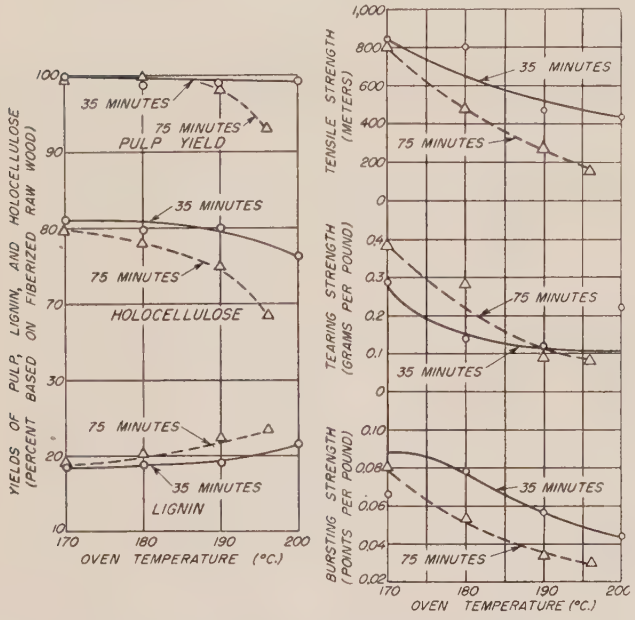


Fig. 10. Effect of temperature of oven heating of aspen chips on yield and chemical composition of fiberized pulp

Fig. 11. Effect of temperature of oven heating of aspen chips on strength of fiberized pulp

The unpasted corrugated boards made from the aspen water- and steam-cooked material had sharply defined corrugations, showed no signs of cracks, and appeared to have excellent stiffness.

EFFECT OF HEATING WOOD CHIPS IN ABSENCE OF WATER

Heating aspen chips having a moisture content of 15% for 35 minutes in a forced-air oven at temperatures from 170 to 200°C. had little effect on yield of fiberized pulp from the treated chips (Table VII and Fig. 10). The yields of 94 to 95% obtained in these tests were nearly as high as the 95.3% obtained from fiberized pulp from raw, untreated wood. Although yields changed only slightly in this treatment, the pulps were affected in a degree dependent on the temperature. The treated chips were more readily fiberized, and the ease of fiberizing increased with temperature. The treatment also caused an apparent increase in lignin content and a decrease in holocellulose (Table VII and Fig. 10). This conversion of carbohydrates into material analyzing as lignin has been noticed by others, as discussed previously. The chemical changes, however, were slight at the lowest temperature of 170°C. The last effect noted was a decrease in strength with increase in temperature (Fig. 11). The pulp from chips treated at the lowest temperature, 170°C., however, was slightly stronger than that from untreated chips (Fig. 11). A slight hydrolysis of the fiber bond may have occurred before the chips lost their moisture, with the resultant beneficial effect on strength noted previously with water and steam cooking. The chips were found to attain a moisture-free condition in 15 minutes at 170°C. This time would be expected to be shorter at higher temperatures.

Heating the aspen chips for 75 instead of 35 minutes at the elevated temperatures brought about a more pronounced action than described above, especially at the higher temperatures. A definite loss in yield was noted in treating at 190°C. or above (Table VII and Fig. 10). At 196°C. the chips were darkened and emitted an acrid odor. This indicated incipient combustion. The lignin yield again increased with increase in temperature, and the holocellulose yield decreased. Carbohydrate material, probably hemicelluloses, was converted under these conditions into both ligninlike material and water-soluble material. Pulp strengths were also generally lower from the longer treating time in comparison with the shorter time (Fig. 11).

A test was made at a temperature of 170°C. with chips having a moisture content of 60%. These chips required 25 minutes to become moisture-free. The pulps made from these chips were about 35% stronger than those made under the same treating conditions from the chips with a moisture content of 15% (Table VII). The higher strength was due to a longer period of hydrolysis and a shorter period of degradation with the chips with higher initial moisture content.

In heating wood chips in the absence of water, the wood is embrittled and undergoes the chemical changes indicated above to a degree proportional to the severity of the treatment. Pulps made by mechanical fiberization of the embrittled chips contained more or less transversely broken fiber bundles depending on the severity of treatment. The pulp made under the most drastic conditions was distinctly sandy.

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Conveyors for Materials in a Pulp and Paper Mill

S. L. FOSTER

The materials handling facilities of The K.V.P. Co. Ltd. plant at Espanola, Ont., are described. Starting with the woods operations, the equipment needed for transporting the pulp wood to the mill and subsequent processing is given. Consideration is also given to the handling of chemicals and other mill supplies used by this mill.

IN A PULP MILL the handling of the pulp wood is of course the big item of materials handling. The storage of a reserve and reclaiming from storage as well as equipment for unloading and delivery to process are subjects that must be considered in the original layout and should be one of the prime factors for consideration in the selection of a mill site. To a lesser degree the same thing is true of all other materials to be used, and it is also necessary in the selection of a mill site to keep in mind the need of track and dock space for rail and truck shipments, as well as boat shipments where the mill location is such that boat shipments are possible.

It is not within the scope of this paper to do much more than mention some of these points and their relation to the final handling at the mill. Experience has shown that the location of a mill where water transportation is possible has a very marked effect on rail freight rates and since this is true it is in many cases necessary to plan the materials handling facilities so as to be able to take advantage of all possible means of delivery of materials to the mill as well as shipments of finished products leaving the mill.

In this discussion the author will not attempt any analysis of how to go about the selection of a plant site and the general arrangement of the mill and buildings, but will rather describe the facilities of a mill that is in operation. This seems necessary in order to give a more complete picture of what is required. The conditions at each mill are different and the thing that fills the needs in one will not necessarily be the best solution at any other.

WOODS OPERATIONS

The K.V.P. Co. gets its wood for the Espanola mill from approximately 5000 square miles of timber limits and from privately owned lands held by farmers, saw mills, and others. The consumption is more than 150,000 cords per year and about half of this amount must be shipped in by rail as it comes from sources such that it would require a long haul to get it to the head waters of the Spanish River. The river-driven wood comes to the mill in the early summer and its handling is simple as will be shown later.

All of the wood cut on K.V.P. limits is stacked in 1, 2, or more cord piles along the strip roads when it is cut. Here it is scaled and left for the winter hauling season. So far no mechanical equipment has been found that can be used to advantage up to this point, particularly on the small wood available. A man with a bucksaw and axe, because of ease of mobility and freedom from breakdown, can and does do as much work as any of the power-driven saws so far tried. It has been found that heavy truck or tractor mounted cranes that can go out the strip roads and load sleds carrying 4 cords each at a high rate do save considerable labor. There are also special tractor mounted rigs that slide a fork under a cord pile of wood, pick it up, and roll it onto a sled rack or truck body. The sleds are brought by a small tractor to an assembly yard where they are made up into trains of ten or more sleds, sometimes as many as twenty-five or thirty sleds, each holding 4 cords. The length of the train depends on road conditions and grades.

The tractor is an interesting piece of equipment. It is driven by a 250-hp. diesel engine and with its load of pig iron weighs about 20 tons. The tires on the rear are 24 inches in diameter and 6 feet high. To add to the weight they are filled partly full of water and antifreeze; each tire has 2 barrels of this solution in it. They haul a train at speeds up to 25 miles per hour.

Most interest is in the unloading of the sleds. At the landing where the wood is unloaded onto the ice preparatory to delivery of wood by water to the mill in the spring the same type of truck or tractor mounted crane can be used to unload the sleds or, of course, standard crawler cranes could also be used for this work. The sleds can also be unloaded by drawing the stakes and tipping. For unloading into cars for rail shipment it has been found that standard derricks and four-drum hoisting engines are ideal equipment. These machines will load an open top, flat bottom car with 16 cords of wood or four sled loads of wood in about 20 minutes. The extra drums on the hoisting engine are used to spot cars and sleds into proper position for loading. Horses are usually used for taking the empty sleds out of the way and getting them into position

Fig. 1. A tractor ready to start out with a train of sleds

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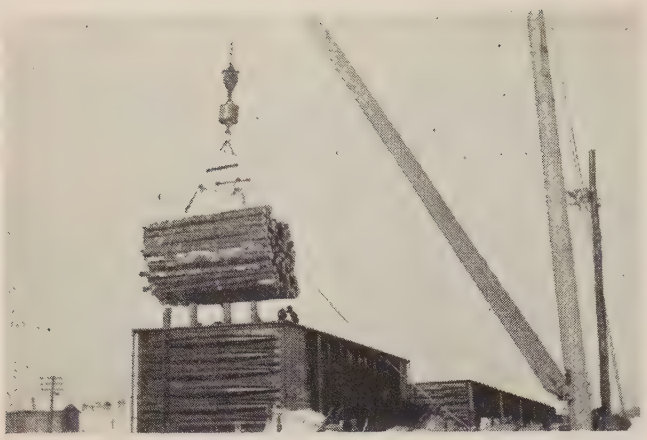

Fig. 2. Loading cars for rail shipment

where the heavy trucks or tractors can pick them up for return to the yard for reloading.

Some operators use tractor-operated, high-line skidders to draw the full tree-length logs to central points where they can be picked up by a heavy carryall and delivered to a portable saw rig at which point the wood is cut and loaded onto trucks or cars for delivery to the mill.

HANDLING WOOD AT MILL

This has been a very brief description of wood handling in the woods and leads up to the beginning of the mill operations. Wood is delivered to the mill by river, by rail, and by truck. Except that which comes in box cars and by river it is all unloaded by either a locomotive crane, or one of several crawler cranes equipped with wood grapples. The wood shipped in box cars has to be unloaded by hand.

Figure 3 shows the type of grapple used for unloading cars or trucks and for picking up stacked wood that is in uniform tiers, and Fig. 4 shows the grapple used for reclaiming wood dropped from conveyors or thrown loosely in a pile. Of unusual interest is unloading dock, shown in Fig. 5, onto which the wood is dropped so that it will slide or roll onto the conveyor. This equipment will easily handle 50 cords per hour and would no doubt handle more if the slasher saw and barking drums inside the plant would take any more. Two crawler cranes of 35-ton weight with 70-foot booms and 125-hp. diesel engines unloading from cars to the river bank handle as much as 100 carloads per

Fig. 3. Grapple for tiered wood

day of 16 hours, this being a two-shift operation. This wood is later brought into the mill by being floated down the river to the haul-out or, as some say, jack ladder although the one installed here is not of the jack-ladder type.

In the case of the river-driven wood it is held in the river holding ground by heavy, rock-filled, timber cribs and booms from which it is put through the sorting gap where the various kinds of wood are separated. The main interest is to sort the spruce and fir into one channel, the pine and other softwoods into a second channel, and the poplar into a third. This permits the use of different kinds of wood so as to get the most out of them. The wood use, being somewhat off from the subject of this paper, will not be discussed.

For about seven months of the year most of the wood used as well as all of the wood that is put into storage for winter use is taken from the river. Perhaps it is more proper to say for use between the time of freeze up and the arrival of rail wood from the winter hauling operations and after hauling operations are complete but before the river opens up in the spring. Since the plant consumption will often go above 500 cords per day at least two months' supply

Fig. 4. Grapple for loosely piled wood

or around 30,000 cords must be stored where it is accessible at all times. The wood-handling equipment must handle about 1000 cords per day. It is believed that the principal problem in this operation that should receive the most attention is the first step of getting this wood onto the haul-out or jack ladder. It is an easy matter to get into trouble at this point and produce a condition that will require eight or more men working hard to correct. In the plant operation being described, a current is artificially created with two 36-inch propellers requiring 25 hp. each, to draw the wood into the conveyors. The natural tendency is for the wood to line up with the run of the conveyor. There are small winches on the wing booms to draw the sweep booms of wood into position so that the current will then take it to the conveyor. The pond boat draws the wood down to where the winches can get hold of it.

Once the wood is on the haul-out conveyor it goes to the slasher saw where it is cut into 4-foot lengths. An attempt is made to drop out as much of the 4-foot wood as possible through a gap in the haul-out conveyor. However, some of it goes through so that there is a mixture of 4 to 8 and 16-foot wood to handle on

the slasher. This requires some extra work as compared to a slasher handling wood all of one length.

To illustrate what some other mills are doing Fig. 6 shows a jack ladder of a parallel type in a recently built Canadian mill. This one delivers directly to the slasher saws and is equipped for mechanically raising and lowering the feed end to compensate for variations in water level. Figure 7 shows a haul-out conveyor with multiple strand chains and large lugs that uses several streams of high-pressure water to assist in getting the wood onto the conveyor. Another mill uses an artificially created current similar to that used by K.V.P. to draw the wood onto the conveyor. One other type of wood haul-out, shown in Fig. 8, has a crossbar with spurs in a very wide conveyor. This conveyor with proper means of drawing the wood onto it has a very large capacity. The crossbars do, however, give some trouble.

The haul-out conveyor and most of the other conveyors on which chains are used are equipped with

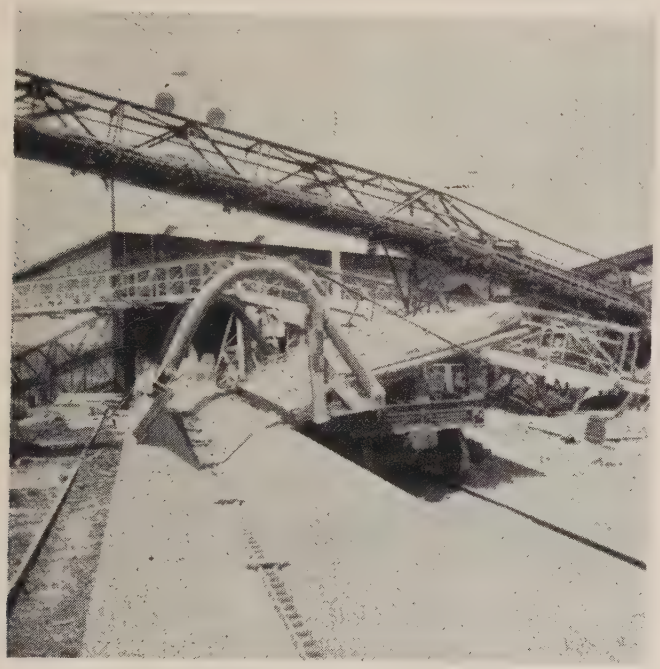

Fig. 5. Rail wood to conveyor unloading dock

No. 111 steel chain with "S" steel attachments. All of the wood conveyors are figured to handle about 60 cords per hour. The wood averages close to 100 sticks, 4-foot long per cord. This gives a basis for comparison with other conveyors. Of course some will handle much more than the rated capacity.

The conveyor of the most rugged construction is the one used to receive rail wood unloaded direct from cars to the mill. The locomotive crane and a clam-type of grapple is used to unload wood from open top cars such as gondolas and flats. Nothing better than hand labor for unloading box cars has been found. Note the wide wings and all steel construction of this conveyor shown in Fig. 5. It has been in operation now for three years and in spite of the fact that it takes a terrific banging it has required very little repairs. Note that a different attachment with a heavy crossbar is used on this chain. This conveyor does not seem to have any limit to its capacity. It so far has handled all that it has been possible to pile on it. In the winter months it

Fig. 6. Jack-ladder-type haul-out

carries mostly 8-foot wood. By the use of a swing gate on the transfer, peeled wood can be delivered directly from this conveyor to the chippers. Since most of the wood is jack pine and pine does not sap peel as readily as spruce and fir the great majority of the wood as it comes is rough. Of course some of the river-driven wood is water peeled to some extent but practically all of it goes through the drums.

In some cases belt conveyors have been used for 4-foot wood. They have some advantage over chain conveyors in that if not supported where the wood falls onto them they have enough elasticity so that they absorb the shock without damage. Also a belt conveyor requires less power to drive than a chain as it is

Fig. 7. Wood haul-out using water jets

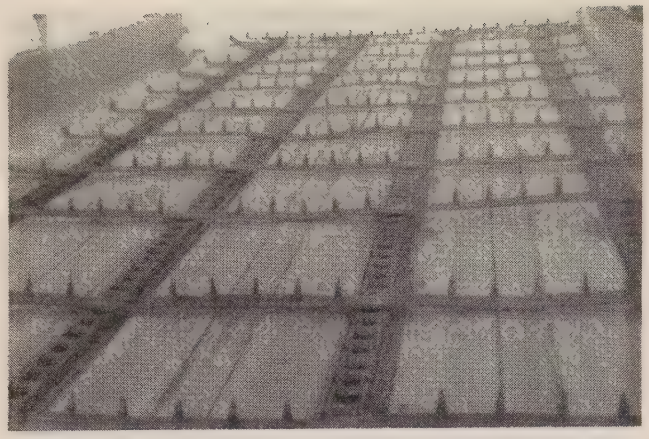

Fig. 8. Crossbar haul-out

all mounted on antifriction bearing rollers. If the wood gets jammed in the trough of a belt conveyor the belt slides under the wood and does no damage. These belt conveyors are used to handle wood to and from the drums and to the chippers. Except for the conveyors removing chips from under the chippers to the chip screens and the bucket elevator to the chip loft, all of the chip conveyors are of standard design belt conveyors. There are several of particular interest. Figure 9 shows the feeders and collecting conveyors on the bottom of the chip bins. Figure 10 is an outside view of the chip bins and also shows a part of the 8-foot diameter steel tube housing the chip conveyor to the digestors. This conveyor tube is 350 feet long and is reinforced with a truss inside which stiffens the tube and provides support for one side of the belt conveyor. This belt conveyor is 36 inches wide, operates at a speed over 500 f.p.m., and delivers 20 tons dry weight or 40 tons wet weight of chips in 15 minutes. A weightometer is used both to get a record of actual wood used and also to get the same amount of wood in each digester. It can be set to deliver any desired weight after which it will stop the conveyors.

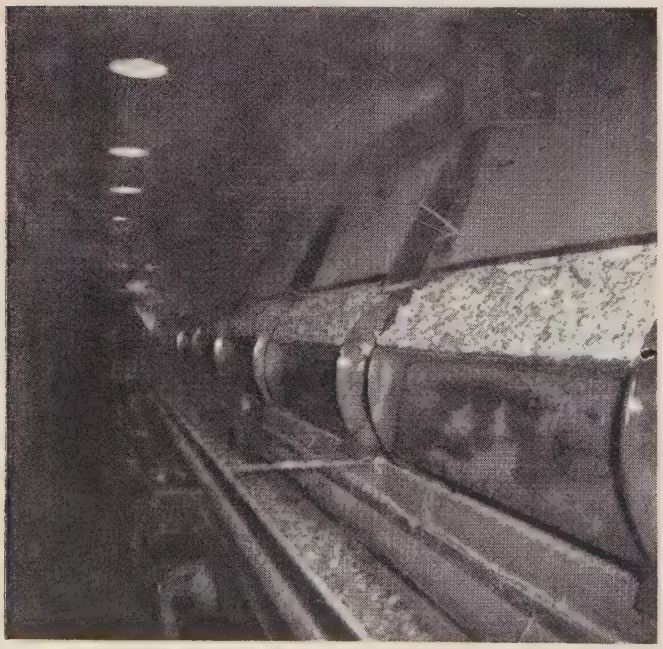

Fig. 9. Star feeders from chip bins

Salt cake and lime are probably the most disagreeable of bulk materials to unload, but a vacuum system has been found to do an excellent job. It takes most of the discomfort out of the job, requires very little repairs, and saves labor. One man unloads a car of lime in three to four hours. It requires 50 hp. to drive the exhauster, and the dust is caught in conventional dust collecting cloth bags, these being cleaned by shutting off the vacuum and shaking the bags. This cleaning operation is purely automatic and is done by small motor-operated equipment. About the only thing that the operator has to watch out for is large lumps or cakes. Buying specifications must limit the size of lumps to be handled by this equipment. The lime and salt cake are stored in vertical steel silos. It is removed from these silos with screw conveyors the speed of which is variable in order to get the desired rate of feed to process. These screw conveyors are typical of several other that have been installed. They can be made reasonably tight so as to keep down dust

Fig. 10. Chip bins and conveyor tube

and if sticks, bars, and similar material are kept out of them they will give very little trouble. The rate of feed is not exact but seems to hold reasonably uniform so as to make a satisfactory job at low cost. The same people that make the Weightometer make a Feed-O-Weight device that, while much more expensive, will, the author has been told, maintain a very uniform rate of feed on a job of this kind.

Probably the toughest material-handling problem in a kraft mill is that of the hot lime from the lime kiln. This requires a water-jacketed conveyor as the lime comes out at a temperature of around 2000°F. or a white heat. A screw conveyor with a water-jacketed trough and a hollow shaft with water flowing through the shaft is used. The flights are a special high-nickle alloy steel designed for heat resistance. This lime should go to a reburned lime silo where it has a chance to cool before going to the slaker. In some cases a cooler is used to cool the reburned lime, the heat being used to heat the air supply to the kiln.

Bark conveyors are all belt conveyors with no special features.

In the bleach plant there are four belt conveyors of special design for handling high-density stock to the caustic cookers and high-density bleachers. These are transite-lined troughs with flat belts and scrapers to doctor the stock off at the desired point of delivery. There are some special features about these conveyors. The belts are made endless on the job by vulcanizing with a portable vulcanizer, and extra care is used to make certain that the fabric is completely protected so as to keep out water or bleach liquor as these would quickly destroy the fabric and cause failure of the belt. Also, the driving pulley does not have the usual solid face but has a ribbed face to prevent a build-up of stock on its face. A rubber-bladed doctor does a good job of unloading this conveyor and discharging at any desired point along the conveyor.

The coal handling is unusual in some respects in that although about 100 tons of coal are burned daily in the winter months there is no reserve in the yard at the mill. The coal is delivered by boat to Little Current which is 35 miles from Espanola. It is unloaded and stored by the Canadian Pacific Railway and delivered to the mill in hopper bottom cars as needed so that all of the coal at the mill is either in the coal bunker or in cars, usually less than a week's supply. The cars are unloaded into a track hopper from which the coal passes through a crusher and onto a belt conveyor delivering to a bucket elevator which discharges onto a standard troughed belt conveyor to the coal bunkers. This is all conventional equipment. In Parchment all of the coal handling is done with locomotive cranes. Here between 250 and 300 tons of coal are burned daily, the amount depending upon the seasons. Coal is received in the hopper bottom cars and some is unloaded by dumping into a track hopper. There are no coal conveyors of any kind at this mill; the coal is put into the coal bunkers over the boilers with the locomotive cranes. On the day shift two of these unload cars and do whatever storage of coal is needed outside of the track hopper as well as reclaim from storage and place the coal in the bunkers. In addition to the locomotive cranes there is a small diesel locomotive for spotting cars and other shifting that may be needed.

Practically all of the baled and lap pulps at both Espanola and Parchment are handled on fork trucks. Because of a long ramp with a 10% grade and for speed and durability gas engine-driven trucks are used. About 100 tons of paper are produced daily at Espanola and this is taken down the ramp and into cars, a run of about 500 feet with two of the same type trucks equipped with scoops for roll handling. This is an 8-hour day job.

The mill produces nearly all of the caustic and chlorine used in its own electrolytic plant. This requires 30 tons or about a car load of salt daily. The salt is brought by water to Little Current where it is unloaded by the C.P.R. into flat bottom gondola cars. A cargo of about 3000 tons is delivered to the mill at the rate of about twenty cars per day and is unloaded with a locomotive crane and clam shell bucket into a large open top tank where it is dissolved by pumping hot water up through the salt. The brine is pumped to the salt room for chemical treatment before going to the cell room. Formerly, a coarse grade of rock salt was stored out of doors exposed to the weather, reclaimed from the pile with a clam shell bucket and crawler crane, and trucked with a dump truck to the salt room. The present system of dissolving and pumping eliminated this handling.

Sulphur is also brought to Little Current by boat and from there in open top cars by rail. Very little sulphur is used so it is handled at the mill by hand in wheelbarrows or concrete buggies.

Resin size is bought in tank cars and is unloaded by the use of air pressure. An enclosed and heated space on the end of a spur track has been provided for this, for sulphuric acid, and for the loading of 50% caustic for shipment.

Receipt of L.C.L. shipments of small supplies and miscellaneous materials is handled by truck or delivery of these direct to the mill by rail rather than by truck. The track on which these cars is set is conveniently located.

HANDLING FINISHED PAPER

One of the features of the paper handling system at the K. V. P. Parchment plant is the overhead tramrail system for picking up rolls of paper at the paper machine winders and delivering them either to any of the converting plants or to storage or finishing and shipping area. The K. V. P. Co., at Parchment converts or processes a large part of the paper machine production and sells it in the form ready for use by the final consumer and while, of course there is some trucking, the overhead system is also used very extensively. Where trucks are used most of them are power operated, either storage battery or gas engine. The heavier units are all gas-engine operated. Most of them are equipped with forks and the paper is transported and stored on pallets. Some is shipped on pallets. A few of the power-driven trucks are equipped with roll-handling scoops that can pick up mill rolls 24 to 36 inches in diameter and up to 84 inches long and load them into cars either lying down or standing on end. These are the same type as are so extensively used by the newsprint mills. The main point about power-driven trucks is that only one operator is required and he travels at a speed more than double that of a man walking. These power-driven units can be obtained in capacities to suit individual requirements. They are like automobiles in that they do require the same type of care and maintenance that an auto requires. This work is done in a regular garage by the same men that look after the other automotive equipment. There is the same problem in most mills. In Espanola as it is necessary to transport supplies to the woods camps and to maintain a large float of tractors, trucks, and autos for this and other general hauling.

In conclusion, general considerations for material handling should be to so arrange equipment as to eliminate the need of as much handling as possible, and where materials have to be moved from place to place to do as much of it mechanically as possible.

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Separation of Dirt from Unbleached Pulp by Centrifugal Type Classifiers

VANCE L. REYNOLDS

The possibilities of removing dirt from unbleached sulphite pulp by use of the Dirtec, manufactured by the Bird Machine Co., and of the Vortrap, manufactured by Nichols-Freeman, were investigated. Results of tests to determine dirt removal efficiency are presented together with the effects of operating variables on classifier efficiency and capacity.

The Nichols-Freeman Vortrap and the Bird Dirtec are well-known equipment that have been used for years to remove dirt from stock in paper mills where installations have been reported as being very efficient (*1, 2, 3*). The classifiers, however, have not found as wide spread use in the pulp industry although the manufacturers have suggested that they can be used with advantage for removing dirt during the process of manufacturing woodpulp. To the best of the author's knowledge Stevenson (*4*) has made the only reported investigation of this possibility. He found that the Vortrap compares favorably with rifflers for removing dirt from bleached pulp but obtained a very low efficiency when unbleached stock was treated under the same conditions. It was therefore the purpose of this investigation to study more thoroughly the possibilities of utilizing this type of classifier to remove dirt from unbleached pulp. The work falls logically into two parts, first evaluating a method for measuring the efficiency of the classifier and second, testing the equipment to measure its efficiency under different conditions of operation.

METHOD

To measure the efficiency of the classifiers it was necessary to have a reproducible method for estimating the dirt content of the pulp stock entering and leaving the units. Dirt in unbleached pulp can be considered as consisting of two types, first obvious dirt specks consisting of bark, knots, pitch, etc., which are quite different from the cellulose pulp fibers, and second, fibers differing from pulp fibers only because they are darker colored or exist as unseparated bundles known as shives. This difference in types of dirt was taken into consideration in establishing the dirt count method and the two types counted separately.

The method found satisfactory was to prepare moisture-free handshects weighing approximately 1 gram each. The moisture-free basis was selected, first to eliminate variations in water content with the resulting differences in translucency of the sheet, and second, to keep extraneous dirt from sticking to the sheets during handling and counting. The 1-gram sheet was selected because heavier sheets made counting of all the specks difficult while lighter sheets did not securely hold the dirt specks. A laboratory speck-count box having a frosted glass top and illuminated by a 100-watt bulb placed below the glass was used for the counts. Speck particles which were 0.08 square millimeters or larger in size were evaluated by a count expressed in square millimeters of equivalent black area per gram of air-dry pulp. On the other hand shive content was expressed as the actual number of shives per gram of air-dry pulp because of the large number to be counted and the difficulty in estimating their equivalent black area.

The many tests contemplated on the classifiers and the subsequent large number of dirt counts necessary for their evaluation made it very important to determine the minimum number of sheets required from each sample to achieve reasonable precision in the work. Therefore, 86 identical handsheets were prepared from a single sample of screened unbleached stock, each sheet counted for dirt specks, and the results averaged. The individual values were then picked one by one at random and the cumulative deviations from the mean plotted until all 86 values were included. This plotting was repeated with the same values selected in a different order; furthermore, the graphs were checked against four additional pulp samples of 30 sheets each. It was concluded from an inspection of the curves that the average speck count for 12 handsheets would always be within 10% of the average for an infinite number of sheets. Also the shive count of each of the 86 sheets proved to be within 10% of the average so that counting of 12 handsheets from each sample was found adequate to obtain results within 10% of the true average.

To measure the possibility of different results arising between two operators, the influence of this factor was investigated. It was found that the average variation between the two operators who had worked together on the method was inversely proportional to the number of sheets counted. When the values from 12 handsheets had been averaged this variation was less than the deviation expected when a single operator counted 12 sheets. The conclusion was drawn that no difference in values would result whether one operator made the determinations or the work was divided between the two. Therefore, to reduce eye strain and monotony the latter course was followed.

It is well known that on many routine operations precision decreases with passing time because of fatique of the operator. A test was therefore made to determine the affect of this factor on results. When a series of handsheets was repeatedly counted for 1 hour, and comparison made between the counts obtained, these comparisons showed no increase or de-

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crease in the average count, and no increase in deviation from that average as time went on. Thus fatigue is not a factor in the results.

THEORY

Having established a suitable method for evaluating the efficiency of the two classifiers, they were installed ready for the experimental work. The general theory of operation of both units is based upon separating dirt through a difference in specific gravity between the dirt particles and the pulp fibers. They accomplish the same function as the rifflers commonly used in pulp mills for settling out dirt of higher specific gravity. However, in this equipment the force of gravity is increased by tangential injection into a cylindrical chamber through a nozzle. The rate of settling is greatly accelerated by the centrifugal force thus generated. By calculation it is estimated that this increase in settling force is 285 times the force of gravity. It is obvious that where differences in specific gravity are large a good separation will occur. This accounts for the recognized success of these classifiers in paper mills where the extraneous dirt found in waste papers such as soil, metal particles, broken glass, etc., are considerably heavier than the fibers. However, the situation differs in unbleached pulp where the objectionable dirt consists of wood particles having essentially the same specific gravity as the fibers. In the latter case, the degree of separation realized will be less, but as will be subsequently shown, a separation does occur due either to slight differences in density between dirt particles and fibers or due to the differences in particle shape and size of the dirt causing less friction pressure drop through the fluid median.

The Dirtec and Vortrap differ principally in the manner in which drawoff stock containing the dirt, hereinafter called bleed, is discharged from the chamber. In the Dirtec, an inverted cone at the bottom permits the bleeding of stock having the highest proportion of dirt from the periphery of the chamber. On the other hand the Vortrap contains diaphragms within the chamber itself to separate from the main stream the stock containing the most dirt.

EXPERIMENTAL

The arrangement of the classifiers for experimental purposes was as follows: the units were installed on the second floor of the screen room under one end of the flat screen lines. A headbox and centrifugal pump were connected by piping to the classifier inlet while outlet lines directed the discharged stock back to the flat screen stock flumes. The headbox piping was arranged so that stock from various points in the screen room system could be used as feed. Additionally, so that the effect of flat screen knotters could be evaluated, a section of the accepted stock flume from one of the primary flat screen lines was blocked off and piped to the classifier headbox making possible the insertion in this location of any size screens to secure different feed stocks for the apparatus.

The screen room wherein these tests were conducted was typical of installations in unbleached sulphite pulp mills. Dirt was progressively removed, first by knotters, then by rifflers and flat screens.

In such a screen room system there are opportunities to insert equipment such as these classifiers at various points in the process to treat stock containing varied amounts of dirt. Therefore tests were conducted with the classifiers to compare their effectiveness when using feed stocks from these various points. The feed stocks used during these tests were as follows:

1. Stock from 24-cut and 18-cut knotter screens.
2. Stock from the reject flume of the tertiary flat screens.
3. Stock from the tailings screen.
4. Stock from the primary flat screens.

The first tests, on stock from knotter screens produced results which indicate that classifiers could be used actually to replace flat screens as far as dirt removal is concerned if they were preceded by 18-cut knotter screens. That is, stock passed first through 18-cut knotter screens and then the Dirtec operated under the factory recommended conditions of 40-p.s.i. inlet pressure and 30 gallons per minute bleed had approximately the same dirt content as average normal screened stock.

In the second test using stock from the reject flume of the tertiary flat screens it was discovered that the bleed orifice plugged immediately with knots and uncooked chips. Therefore the classifiers could not be used with a feed stock which had not been previously subjected to some other screening process than the very course knotters.

Results of the third test on the stock from the tailings screen showed a reduction in specks of 43%. However, since the tailings screen processes only 1.3% of the total production, a removal of only 0.65% of the total dirt in the final pulp was indicated which caused the abandonment of further testing of this stock.

In the fourth test on stock from the primary flat screen the Dirtec removed 30% of the total specks and 10% of the shives when operated with the recommended 40-p.s.i. inlet pressure and 30 gallons per minute bleed. These results indicated the possible use of the classifiers for treatment of all screened stock. Thus additional tests were conducted using this stock to find the optimum conditions of maximum dirt removal and capacity for the unit.

The variables of operation affecting these conditions are as follows: (1) feed flow, (2) inlet pressure, (3)

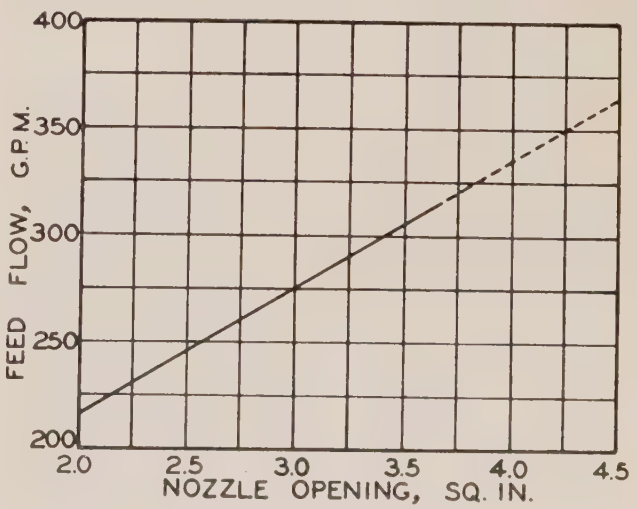

Fig. 1. Effect of nozzle size on Dirtec capacity

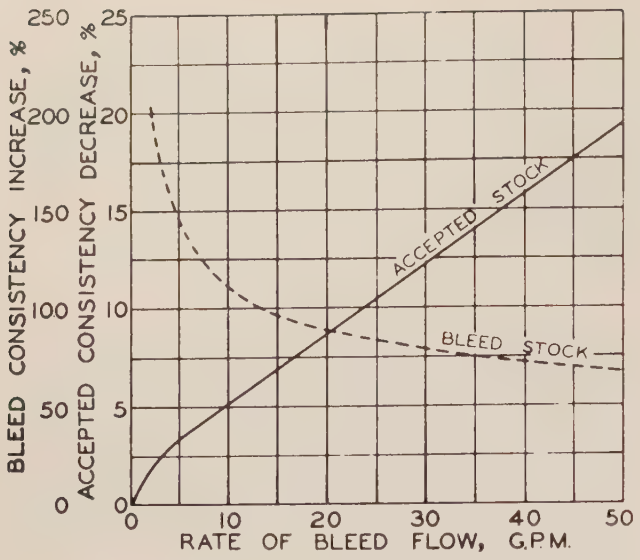

Fig. 2. Effect of bleed rate on Dirtec outlet consistencies

feed consistency, (4) outlet pressures, and (5) bleed flow.

The effect of feed flow and of bleed flow on dirt removal efficiency, capacity, and consistency of clarified and bleed stocks was investigated. The other variables listed were held constant or varied only as necessary to gain the desired capacities and bleed flow. Feed was maintained at the fairly constant consistency of the stock from the flat screens which was 0.4%.

The effect of feed flow, controlled by inlet nozzle size, on capacity and efficiency was determined with the cooperation of the Bird Machine Co. Four especially constructed nozzles with apertures varying between 2.05 and 3.64 square inches were in turn installed in the Dirtec and tested under the constant conditions of 40-p.s.i. inlet pressure, 30 gallons per minute bleed, and 0.4% feed consistency. It may be seen in Fig. 1 that the capacity of the unit varied directly with the nozzle area. On the other hand, speck and shive removal were not affected by the size of the aperture within the range tested. Since no loss in efficiency resulted, increased capacity of the units could be realized by enlargement of the nozzle.

Centrifugal force within the classifier chamber causes fiber as well as dirt to be thrown to the chamber wall during operation. Therefore the stock loss in the bleed will be greater than that indicated by the volume ratio between bleed and clarified stock flows. For purposes of engineering calculations the magnitude of this effect was determined with several bleed flows as plotted in Fig. 2.

It is obvious that there will also be no clearly defined line of separation between dirty stock at the periphery of the chamber and the clarified stock at the center. Thus stock having a very high dirt concentration will be withdrawn with a low rate of bleed, but the maximum dirt removal efficiency will not result. By increasing the rate of bleed to withdraw the adjacent annulus of stock, more dirt, but not of such a high concentration, may be removed. To establish this relationship between dirt removal and bleed flow the dirt counts of the feed and clarified stocks were compared as the bleed was varied under otherwise constant conditions. Results are shown on Fig. 3. It may be seen that without any bleed a negligible removal is obtained. Thus the collection sump is of little value with unbleached stock. On the other hand a bleed of 30 gallons per minute, or 13% of the feed, gave 30% removal, and with a 45-gallon per minute bleed a 36% removal was obtained.

This bleed containing the dirt also contains a very considerable amount of usable fiber. The practical application of the classifiers requires the recovery of this stock, and this recovery can be accomplished by the treatment of bleed stock with additional classifiers if these units will clean the bleed to a dirt content equal or less than that of the original feed. Under these conditions the clarified bleed could be returned to the original headbox for retreatment while the rejected portion of the bleed could be passed through a third unit for clarification and return to the system. This possibility was investigated in the following manner.

The classifier was operated with screened stock at an inlet pressure of 40 p.s.i. and a 30-gallon per minute bleed. The clarified stock was returned to the screen stock flumes while the bleed was collected in large drums. The operation was then halted, the system thoroughly cleaned, and the bleed stock transferred from the drums to the headbox. The unit was then put into operation and bleed again collected. Finally after again cleaning out the system, the second bleed was returned to the headbox so that the effect of a third separation could be noted. Samples of all stocks throughout this process were taken so that dirt count conparisons could be made. Results of this comparison indicate that each clarified bleed is slightly cleaner than the feed entering the preceding unit. Thus the plan outlined above for recovery of the bleed stock was proved feasible, and all stock can be returned to the system except the small bleed from the final or tailings unit.

Figure 4 is a schematic diagram of such arrangement for a 100-ton mill using 6-inch Dirtecs as the classifiers. These calculations are based upon a feed of 280 gallons per minute, and a bleed of 30 gallons per minute. Consistency of the feed was assumed to be 0.35% with clarified stock and bleed consistencies as shown on Fig. 2. This arrangement could be enlarged for

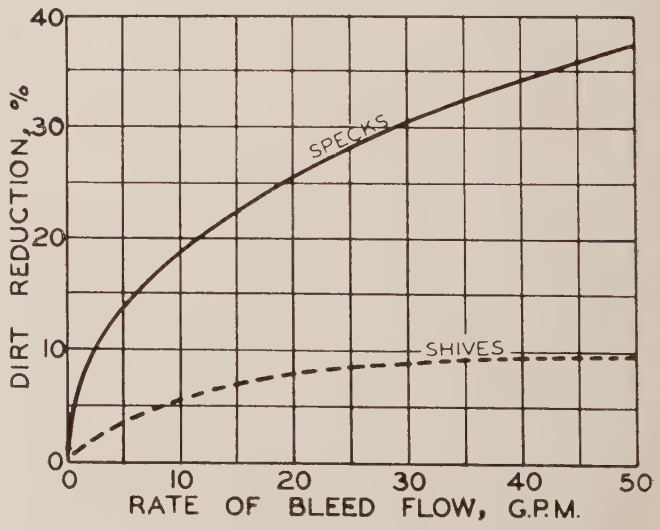

Fig. 3. Classifier efficiency as related to bleed flow rate

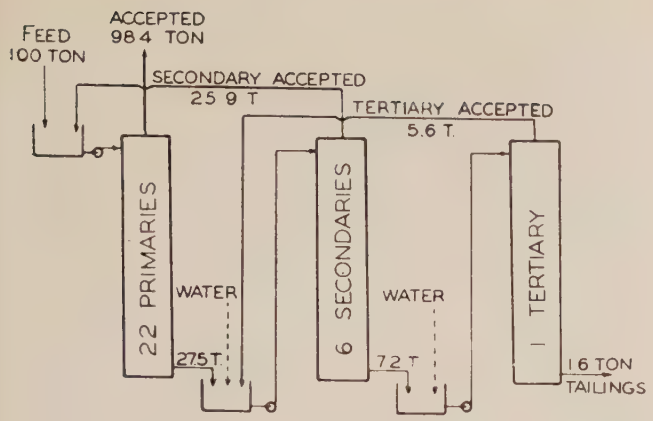

Fig. 4. Classifier flow diagram for a 100-ton mill

greater capacity by addition of classifiers at each step and by introduction of a quaternary unit to maintain the low-tailings output.

SUMMARY

It is realized that the results of this work, obtained with unbleached sulphite pulp at the plant of the Puget Sound Pulp & Timber Co., may differ from results obtained at other mills where the conditions of operation are not the same. Also, it should be pointed out that this was not intended to be an exhaustive study of centrifugal dirt separation. With these reservations in mind, however, there is every reason to believe that the results set forth are indicative of the results to be expected in other similar installations. In summary the findings were:

1. The Dirtec and the Vortrap have been found to remove dirt from unbleached sulphite pulp in the order of 30% of the specks and 10% of the shives.
2. Experimentation indicated that a high-positive bleed is necessary, and that the sumps as settling chambers are ineffectual with unbleached stock.
3. An installation of these classifiers can be so arranged that losses of acceptable fiber are held to a minimum.
4. There is no apparent change in unit efficiency when capacity is increased by enlarging the inlet nozzle.
5. Although it was not the purpose of this paper to critically compare the Vortrap with the Dirtec, results of tests made on both of the classifiers indicate that they are about equal in dirt removing ability.

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Some Factors in the Strength of Paper

WILFRED GALLAY

The structure and physical properties of pulp fibers are discussed with special reference to a comparison of cellulose with a general range of linear polymers showing a close integration in this general field. The question of preexistence of fibrils and other fine structures in the fiber is examined and an alternative interpretation of these bodies is preferred. The meaning of limited swelling in linear macromolecules in general, and in cellulose fibers in particular, is discussed, and the importance of the degree of swelling of a pulp fiber is emphasized. True adsorption is sharply differentiated from general imbibition, kinetically and thermodynamically. The possible effects of varying degrees of colloidal swelling on the beating process and on the strength of the paper is discussed. Mechanical disorganization of the structure at the surface of the fiber and of the whole fiber is discussed in relation to bonding and paper strength. Requirements in suitable extraneous bonding materials or adhesives for pulp fibers are discussed. Attention is drawn to the possibility of failure within the fiber rather than in the adhesive layer.

This discussion is not intended as a systematic review of the very voluminous literature available on the various factors involved in the strength of paper. It is intended rather to emphasize certain points of view in connection with some of these factors, and to draw what appear to be pertinent and logical analogies from other fields in the interpretation of the structures and behaviors involved.

Paper consists of a web of fibers, the structure being held together partially by bonding among fibers at junction areas, and partially by friction between fibers as a result of a relatively intimate interweaving during deposition. There has been a considerable tendency to minimize the importance of the friction factor, but there appears little doubt that this structural factor assumes increasingly greater importance as the fibers are made more flexible by working. Some unpublished data obtained in the author's laboratory and forming part of a broader program to be discussed in due course, are particularly striking in this regard. When paper is stressed to failure by burst, tear, tensile pull etc., unfortunately no clear-cut evidence or data are available as to the actual manner of failure. Microscopic observation of the progress of such stresses applied until the paper fails, would appear to indicate very little actual rupture or break in the fibers themselves. The effect would appear to be mainly one of a slipping apart of fibers in the stressed area, and these observations have led to the general conclusion that bonding between fibers is the most important factor involved. Fibers properties other than bonding ability are however undoubtedly involved, e.g., flexibility and degree of elasticity. It is necessary there-

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fore to take into account the structure of the fiber, and the effect of various types of working on this fiber, as well as the factors relative to interfiber bonding.

FIBER STRUCTURE

A considerable amount of work has been carried out on the fine structure of the pulp (*11, 12, 13*). It has been shown that, as a result of rather drastic treatment with acids and alkalis, the fiber may be separated or resolved into a series of concentric sleeves, like the layers on an onion. By various types of mechanical manipulation, the fiber may be separated into finer fibers termed fibrils. These fibrils are in the main orientated essentially in the direction of the axis of the fiber, but those on the outside (and probably also those adjacent to the lumen) are disposed at a very large angle to the fiber axis. These fibrils in turn may be sub-divided into sub-fibrils which in turn are probably resolvable into more minute structures. It is presumed that the concentric sleeves which have been clearly observed are composed of rings of fibrils held together normal to their axes. Some very beautiful photographs have been published showing these various units of fibers, and delicate techniques have been developed for their separation in various forms.

On the basis of this work, it has been concluded by several of the investigators in this field and quite generally accepted by others, that these fibrils and other sub-structures pre-exist in the fiber. The latter has indeed been likened to a rope consisting of strands (i.e., fibrils), which in turn consist of threads (i.e., sub-fibrils) etc. This question of what might be termed the homogeneity of the fiber is a basic concept of considerable importance, and it may be well to examine another possible interpretation.

Let us consider, for example, a strip of unvulcanized natural rubber. As amply shown by absence of double refraction and by a broad diffused scattering in x ray diagrams, this material is entirely amorphous. It consists of long-chain molecules of very high-molecular weight disposed at a virtually complete degree of randomness. If we stretch this rubber strip, a considerable degree of orientation of these chains is induced, the amount being dependent on the elongation. When the stress is removed, the rubber strip snaps back to its original dimensions. Thermal forces, similar to that causing Brownian movement, act on segments of the long chains to restore them to the state of higher entropy, and the induced partial orientation is lost. If such a rubber strip is dipped into liquid air for a few moments and then struck with a hammer, the material fractures with complete irregularity, as would be expected of an amorphous material. When such a rubber strip is however elongated by stretching, and dipped into liquid air while still under stress, and then struck with a hammer, the results are quite different. The strip fractures into beautifully aligned fibers which in turn consist of fibrils, etc.

Essentially similar experiments can be carried out with any thermoplastic material. Natural rubber was chosen as an example because of the virtually complete absence of crystallinity in the natural unstressed state, and because it was the material used by Hock in his classical experiment some years ago (*9*). It is noted therefore that any amorphous fiber of thermoplastic nature may be sub-divided readily into fibrils, sub-fibrils etc., merely by inducing an orientation and then providing a means for stabilizing this induced orientation. In the case of the pulp fiber, it is of course not necessary to induce an orientation since the constituent long-chain molecules already possess a high degree of crystallinity, and it is not necessary to stabilize this orientation, since this is already well taken care of by the highly polar substituents of the carbohydrate molecules. The analogy would appear to be very marked and applicable. It would of course be impossible to claim that natural rubber or other thermoplastics consist of pre-existent fibrils, and yet such sub-structures can be readily produced, given the artificial circumstances described above. Under the stresses noted, the thermoplastics undoubtedly possess lines and zones of strength and corresponding lines and areas of relative weakness. It is along such weak lines that the structures break to yield sub-structures. The relationship of lines of cleavage with strain lines and areas in thermoplastics is well recognized. It would appear quite logical that in a pulp fiber also, the partially oriented cellulose will fracture under mechanical stress or chemical attack along similar lines of weakness as a result of differentials in closeness of packing, orientation, and other physical arrangements in the mass.

It is important to note in this connection that there appears to be somewhat of a lack of integration of cellulose with the thermoplastic field, presumably as a result of the fact that cellulose is hydroplastic rather than thermoplastic. The interpretation of the pulp fiber as consisting of pre-existent discrete sub-structures tends to differentiate cellulose sharply from the general field of long-chain molecular compounds, which differentiation, unless it is completely justified, tends to make unrelatable a considerable store of valuable data from this important field. The general concept of the structure of a material consisting of long-chain units of high-molecular weight, borne out by a mass of evidence, involves a range of properties depending chiefly on (1) the freedom of rotation of the bonds linking the units, (2) the polarity of substituent grouping, and (3) the frequency, size, and shape of substituent groupings. Thus, the degree of orientation may vary from nil to very high; the physical properties of the mass from highly elastic to rigid, etc. There appears to be no reason for a segregation of cellulose outside of this general range of compounds, or for any viewpoint other than a difference of degree rather than type, between the pulp fiber and any other substance consisting of linear polymers.

SWELLING OF FIBERS

The degree of swelling of pulp fibers would appear to be of the greatest importance in relation to the strength of paper, as discussed in a later section, and is closely related to the structure of the fiber.

It is of interest to consider again the case of a typical amorphous thermoplastic, viz. natural rubber. When rubber is stretched, a degree of orientation and crystallinity is introduced and, in keeping with crystallization in general, heat is evolved. If a strip of

rubber is stretched to a moderate degree and cooled, and this stretching and cooling carefully repeated a number of time, a very high degree of elongation can be reached, e.g., 10,000%. The material now shows a series of very sharp interferences in the x ray diagram, and it is clear that this simple process has converted an amorphous substance to one which is virtually a single crystal. The density has been correspondingly increased. Although natural rubber possesses no polar substituents for intermolecular attraction, the "racked" rubber is rigid and relatively brittle. The mechanical properties approach those of an inelastic fibrous material. The extremely high degree of orientation induced by racking brings about a multiplication of the very weak secondary valencies between adjacent chains, and this reinforcement is sufficient to overcome the disorganizing thermal forces at normal temperature which would otherwise bring about a reversion to a random state of orientation. Natural rubber in its normal amorphous state swells hugely in aromatic hydrocarbons taking up many times its weight of liquid and still retaining coherence. Racked rubber, on the other hand, shows no appreciable swelling in solvents over long periods (*5*). It is apparent that there is no means of ingress for the solvent into the highly ordered mass. Linkages normally available to the solvent, are not available in the racked rubber as a result of the saturation of forces, and thermal forces for the separation of the molecules are inoperative. The enormous swelling power of the amorphous material has been nullified merely by attaining a highly ordered state. If the racked rubber is warmed, the increased thermal forces become sufficiently great to disrupt the structure, the material melts and contracts, and the amorphous rubber now shows normal very high swelling in solvents.

This general relationship holds true for all thermoplastics, having regard again for the factors noted above which yield a range of properties in these linear polymers. It is apparent that the degree of crystallinity and the strength of the intermolecular bonds will affect basically the ability of a linear high polymer to swell in a suitable medium. The cellulose in a pulp fiber shows a relatively high degree of orientation, and this crystallinity is maintained by polar forces of a very high order. It is to be expected therefore, that the pulp fiber shows only a very limited swelling in water. Furthermore, in view of the structure of the units of the cellulose chain, allowing for close packing, and the powerful intermolecular bonds involved, cellulose is not thermoplastic and the degree of swelling cannot be increased by heat. The general picture of the pulp fiber as a single structure is thus emphasized, consisting of long-chain molecules, a large proportion of the segments of which are highly ordered and rigidly bound. The swelling is limited to accessible portions of the material where thermal forces are still operative in the separation of segments of the chains not so ordered and bound.

FIBER SURFACE AND BONDING

The adhesiveness of a material is strongly dependent on the physical state of the surface which enters into the adhesion. For two surfaces to adhere, a degree of compatibility or attraction is required, and the bonds involved must be sufficiently strong to yield the requisite adherent strength. In any event, the primary requisite is the physical state of the material at the surface of at least one, but preferably both, of the materials to be joined. Two pieces of dry animal glue will not stick on close contact. The surfaces must possess a certain degree of tackiness. Tackiness depends on the mobility or partial freedom of the molecules resulting from a swelling of the surface by a liquid. Two pieces of animal glue, in contact at moistened surfaces, will show very strong adhesion on drying since the surface swelling enabled an intimate intermingling of molecules to take place, with later fusion on drying. The molecules taking part in the adhesion lose their identity insofar as belonging to one or the other of the two adhered masses. Similarly, two pieces of cellulose acetate, either unplasticized or plasticized with normal amounts of plasticizer, will not adhere on contact under reasonable pressures. If however, the surfaces are rendered tacky by swelling with a solvent, the two surfaces are strongly adhered on drying. In some instances, there may be a considerable degree of intercrystallization at the joint, and in others merely an amorphous type of fusion.

In order to effect fusion following drying then, the surfaces must possess a degree of tackiness. The requisite degree of swelling to produce this tackiness will depend, as noted in the previous section, on the degree of crystallinity in the surfaces to be adhered. The extent of orderliness of arrangement at the surface of a pulp fiber results in only a very small amount of plasticization or swelling in water. Where such is the case with organic plastics and an organic solvent, heat is used in order to provide extra thermal motion to the molecules to assist in reducing crystallinity, but this is not possible with cellulose. Some other means must therefore be used in this endeavour.

The means universally used is that of a mechanical bruising of the surface which effects a considerable disruption of the highly crystalline portion of the fiber, thus permitting the ingress of water during the mechanical working, and enabling a plasticization of the surface by water to take place and hence the requisite tackiness to be attained for fusion following drying. The mechanical action is mainly that of shearing and rubbing with the normal devices used.

That such mechanical disruption of the molecular organization at a surface of a relatively highly crystalline material actually results in increased swelling and tackiness of the surface, can be demonstrated in various ways on a variety of high-molecular weight materials. Starch provides an example of particularly close analogy, in view of the very close relationship chemically and the natural occurrence of starch in discrete particles of distinctive shape, just as in the case of cellulose fibers. Native starch granules suspended in water show no tendency whatever to adhere to one another. Starch suspensions in water sediment with close packing, and the granules sediment individually (*6*). On a microscope slide, the granules roll past one another freely with no tendency to adhesion. Aqueous suspensions of starch of the proper concentration show very strong dilatancy, a basic criterion for which is

absence of adhesion among units in suspension. Dilatancy is shown by unchanged viscosity with varying shearing stresses and is very probably based on a compacting or close packing of the dispersoid ahead of the stress. It is apparent that this ability to pack closely must be accompanied by lack of adhesion. As would be expected from the above, aqueous suspensions of native starch show no thixotropy at any concentration.

If dry starch is subjected to a very mild grinding action and then suspended in water, the properties of the suspension are changed to a very marked degree. The dilatant effect is now entirely lost and the suspension shows a moderate degree of thixotropy. The sedimentation volume is increased as a result of structure in the suspension. It is apparent that the granules now show a marked degree of adherence to one another as a result of surface bruising. In any one granule, a bruising of the surface can be shown microscopically to produce a marked localized swelling at the site of injury (*1*) similar to the well-known ballooning effect of strong acids on pulp fibers (*14*). The starch suspension possesses a somewhat slimy feel reminiscent of the "wetness" of beaten pulp fibers. This swelling, brought about by a localized mechanical disruption of the organized structure, provides the tackiness evidenced by the physical properties of the suspension described. It would appear altogether likely that the cellulose fiber, which shows limited swelling similar to that of the starch granule, undergoes a similar change as a result of mechanical disruption at the surface.

One further point of analogy between starch and cellulose is of particular interest in the present problem. Van Leeuwenhoek (*10*), the inventor of the microscope, observed swollen or gelatinized starch granules over 200 years ago, and postulated on "outside layer" or retainer membranes as forming part of the structure. Since that time, investigators have advanced arguments supporting and contrary to this conception. Without going into the details and merits of the evidence and interpretation (*2*), it may be reasonably safely said that the weight of evidence is definitely against this conception of a retaining membrane on the starch granule. This is of particular interest in view of various investigations in recent years concerning an outside membrane on a pulp fiber (*3*), and conjectures as to differences in chemical composition of this portion of the fiber, aside from differences in angle of orientation. The conception of the disorganization of the surface with its attendant effects on swelling, tackiness, and bonding would appear to suffice in explanation of the phenomena noted without the introduction of a differential layer on the outside.

PREPARATION OF FIBERS FOR PAPERMAKING

The stress-strain properties of materials consisting of linear molecules of high-molecular weight vary over a wide range. Such materials may be hard or soft, may show a low or high extension on stress, and high or low retention of elongation after the release of a stress. They may range from extremely brittle to very tough in impact strength. The basis of such behavior lies in the structural configuration of the unit of which the linear chain is composed, on the size and polarity of substituents of chains, and other factors. The molar cohesion, in calories per mol, has been measured for a number of linear polymers and may be related quite closely to the physical properties of such materials. The magnitude of this molar cohesion represents in general the tendency of such a polymer to become ordered and crystalline, against the disorganizing thermal forces tending to bring about a disordered state. This balance of crystalline vs. amorphous state may be strongly shifted by the intimate admixture of a liquid of low molecular weight which is compatible with the polymer. The net effect of such liquids, termed plasticizers, is to render segments of the polymer chain more susceptible to thermal motion by reducing or neutralizing the cohesive effect of polar substituents along the chains. With polymers possessing strong polar groups, in general a considerable degree of toughness and "long-range" elasticity is introduced since scattered areas remain cohered and intermediate segments are loosened for high stretch. Some polymers possessing only weakly polar groups are merely softened by the introduction of plasticizers since no strongly anchored points remain to prevent a slippage of chains past one another during stress.

In the case of cellulose, the plasticizer must possess very high polarity in order to be compatible and to distribute itself uniformly among the polymer units insofar as accessibility will allow. Water is one of the very few materials possessing such an order of polarity, and is of course the medium practically used. Water is therefore a good plasticizer for cellulose in every respect except that of high volatility and consequent lack of permanence. As was noted earlier however, because of the relatively high degree of crystallinity of the cellulose fiber, water possesses only a very limited power of swelling for the cellulose. We are dealing therefore with a polymer plasticized to only a limited extent with accompanying marked degree of brittleness and rigidity. With typical thermoplastics, relatively small differences in plasticizer content bring about very large changes in toughness and hardness. Thus an increase of only 5% plasticizer, based on the weight of the resin compound, will commonly change a relatively inextensible and brittle thermoplastic compound to one possessing a high degree of elongation and impact strength.

Such alterations in the physical properties of pulp fibers would appear to be very desirable from several points of view. During deposition on the wire and also during pressing and drying operations, increased flexibility in the fiber should be reflected in a more intimate contact among fibers resulting in a great number of bonds per unit area and hence greater bursting and tensile strengths. The greater degree of interweaving or interlacing of the fibers should produce also greater tear and fold strengths. Any brush-heap pattern or higher angle of weave during deposition would be greatly reduced.

The attainment of this increased degree of plasticization of the pulp fiber is very difficult. The inaccessible or highly ordered areas are not rendered more accessible by the action of heat which is the normal procedure used for thermoplastic resins. Failing suitable

chemical means toward this desired end, resort is had to mechanical disruption of this organized state. It was noted in a preceding section that such an action probably produces a surface swelling in relation to bonding. In conventional devices used for this purpose, e.g., various types of beaters, hydrafiners, etc., it is apparent that the mechanical action affects portions of the whole fiber. A mechanical working of these sections of the whole fiber takes place which in all probability brings about what might be termed a multifilament effect on the fiber involving a loosening of the whole structure and a considerable degree of disorganization and hence an accompanying greater degree of plasticization by water. The fiber should thus be rendered more flexible and tougher. Unfortunately the fiber during the early stages of this mechanical action is, in general, too brittle to withstand the mechanical action administered without more or less serious splitting and breakage. Thus a considerable part of the advantage gained may be nullified by the harm done. It has frequently been stated that a considerable degree of fibrillation is required for increased strength. Unpublished experiments in the author's laboratory have shown clearly that a relatively high order of bursting strength with good maintenance of tear strength can be attained with no visible indications whatever of fibrillation as viewed under high magnification. This was accomplished by devices yielding special types of mechanical working on a laboratory scale. It would appear likely rather that extensive fibrillation is detrimental to strength as a result of the weakening of points of attachment to the fiber wall despite the greater bonded area produced. It has been shown (*4*) that fibrillation as such is not the desired end. In this case, pulp was beaten in a liquid of low dielectric constant until considerable typical fibrillation was produced. The pulp was then transferred to water, but the resultant paper had very low strength. The author noted (*4*) that his experiments "cuts across every theory so far advanced for the development of strength on beating." The explanation would appear to be clear on the basis of the reasoning given above. The branches or fibrillation produced by a tearing action in the organic liquid still partake essentially of the original organized and unworked structure. No plasticizer (water) was available for entrance into the structure during the mechanical action on the fiber. It would be expected therefore that such a procedure would result in a decrease rather than an increase in strength. The net desired effect in mechanical working is probably that of a general multifilament effect with no actual splitting off of branches or portions of the structure as is evident in fibrillation.

SWELLING OF PULP FIBERS AND STRENGTH DEVELOPMENT

There appears little doubt that increased swelling of the intimate structure of the fiber is required for increased pliability. On the basis described above, it would appear that an increase in swelling (or plasticization) is the fundamental basis of what is sought as a result of beating and allied mechanical means. The unbeaten fiber may obviously vary widely in its ability to withstand the drastic beating action depending on the degree of swelling prior to beating. Lacking a sufficient degree of pliability and toughness in the unbeaten fiber, the value attained by the subsequent mechanical working would be to a considerable extent nullified by damage done to the fiber. The properties of pulp fibers on which the degree of swelling depends is a broad subject which cannot be discussed in detail here. There is a large mass of experimental evidence showing the relationship of hemicelluloses to this factor, but the general picture is still considerably confused when one attempts to base pulp evaluation (for one type of pulp) on the quantity of hemicellulose present. It would appear altogether likely that a "quality factor," as well as a quantity factor, must be taken into account. The further elucidation of such a relationship must await further knowledge of the constitution and structure of these hemicelluloses.

A further analogy with starch appears to be of considerable interest in this regard. When a suspension of starch is heated, an enormous swelling of the granules is obtained within a narrow range of temperature termed the gelatinization point. If an ungelatinized starch suspension is treated with very dilute mineral acid below the gelatinization point, no visible change is noted in the appearance of the granules or the properties of the suspension. When, however, this acid-treated suspension is heated above the gelatinization point, the extent of swelling of the granules is very greatly reduced (*7*). The starch is eventually dispersed to a sol of reduced viscosity as compared to the untreated starch, but the maximum swelling is far less. At the same time, granules which have been acid-treated below the gelatinization point and dried, show a considerable embrittlement as compared with untreated starch suspended and dried in the same way (*7*). The relationship between decreased swelling power in water and decreased resistance to mechanical stresses is quite striking. The basis for this relationship is not clear and will not be discussed for the present purpose. It is difficult to resist the temptation, however, to draw an analogy between untreated (or alkali-treated) starch granules vs. acid-treated starch granules on the one hand, and sulphate vs. sulphite pulp on the other. It has been shown (*15*) by classical swelling pressure methods, that sulphate pulp exerts greater swelling power in water than sulphite. The differences in strength development and ease of fibrillation and slime development in beating between these types of pulp are well known. Such data might prove very valuable in an evaluation of sulphite pulps if swelling power and strength development were found to be closely related since the very cumbersome beating, sheetmaking, and strength measurement procedures might then be avoided.

One further point on this matter of swelling of high polymers in a compatible liquid might well be emphasized. There has been considerable confusion with regard to the role played by adsorption in swelling processes. Adsorption involves a saturation of forces and is therefore exothermic in nature. If adsorption were the causal factor in swelling, it is evident that such swelling would be exothermic in nature throughout. It is known however that the extensive colloidal swelling shown by long-chain polymers is in general

exothermic in the first stages only. This exothermic swelling is followed by further swelling which is thermally neutral, and the last stages of swelling may even be endothermic (*8*). It is apparent therefore that swelling is a complex phenomenon in which adsorption is only one of the factors, and one which governs only in the early stages of the swelling. Adsorption is essentially a static surface phenomenon, and such surface forces would not be expected to extend the distances involved in the huge swelling where the linear polymers take up many times their weight of liquid. The modern conception of freedom of rotation of valence linkages with consequent continuous change of shape of the polymer under the influence of thermal forces but representing in general a coiled-up form, involves further the concept of large proportions of immobilized liquid. This liquid is immobilized among segments of the chains in a dynamic equilibrium which depends on temperature. This immobilization as such is not accompanied by any change in free energy level, but the separation of the chains, or segments of chains, through further immobilization must involve an expenditure of energy. This concept may be the explanation of thermodynamically neutral and endothermic swelling. The total imbibition of liquid by a linear polymer, on this basis, would consist of adsorption and immobilization. The relative importance of adsorption would depend on the polar forces involved. It must be emphasized however that physical data, such as heat of wetting and other thermodynamic changes, should be interpreted cautiously in relation to colloidal swelling, in view of the various factors involved.

EXTRANEOUS BONDING AGENTS

Extraneous materials have been used to some extent for the purpose of providing fiber to fiber bonding, either in addition to that developed by beating, or partially or wholly as a replacement for bonding area developed by beating. Starch is a common example while other high-molecular weight materials soluble in water have also shown considerable promise. More recently, various thermoplastics in the form of aqueous emulsions have also been applied. Thermosetting resins in the A stage, soluble in water, have been applied to some extent at low concentrations, and B stage resins are used for rigid laminates at higher concentrations.

Extraneous bonding agents for pulp fibers must in general be of relatively high-molecular weight. In common with general adhesive practice, the molecular weight must be sufficiently high for good cohesion in the bonding layer but not so high as to give poor mobility during the bonding process. A marked tendency toward crystallization in the adhesive is a great disadvantage. Crystallization of a water-soluble material involves an increase in density during the last stages of drying subsequent to the bonding action, and this physical change is accompanied by a shrinkage involving crazing and cracking in the adhesive layer. Starch is a notable example showing this effect. Crystallization involves also generally a rigidity and lack of toughness which prevents extensive reinforcement among bonded areas. With the organically soluble thermoplastics, a plasticizer may be used to reduce crystallization, but excess plasticizer may lower the specific adhesion of the resin to the fiber by a masking or lubricating action. With thermosetting resins, it is altogether likely that the low-molecular weight materials applied bond lightly to fiber surfaces initially, followed by an intercondensation between portions on two neighboring fibers to a high-molecular weight layer and a chemical condensation with groupings on the fiber. High wet strength is thus attained.

In general, the addition of extraneous bonding materials resembles in effect the first portion of a beating curve. With the addition of more bonding agent, the burst and tensile strengths increase and the tear strength decreases. A combination of high specific adhesion to the fiber with marked toughness might alter this picture considerably. It may be that the rupture of fiber to fiber bonds in many instances does not result from a failure in the adhesive layer but rather in that portion of the fiber structure adjacent to the bonded area. This is occasionally observed in plywood where a low strength may be found in the glue line accompained by 100% wood failure (and no failure of the adhesive). In other words, the glue line is here stronger than the wood itself. Bonding by fusion of adjacent surfaces of thermoplastics, if properly carried out, results virtually always in a bond which is stronger than the general mass, and failure on stressing does not follow the line of bonding. This might be expected in view of strain lines and areas in the body of the material. It would be of very great interest and importance in this connection to determine whether so-called bonding failure in paper is actually related directly to the "glue line" between fibers, or whether such failure may occur in the fiber wall at a point distinctly removed from the actual surface. If the latter were found to be the case, then the strength of the fiber structure in shear and tension would be the dominant factor in what we now consider to be bonding strength, and fiber strength would have to be considered in a somewhat different light than that usually meant at present.

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Equipment for Heating and Ventilating a Bleach Plant

The Minnesota and Ontario Paper Company

J. H. DAVIDSON

The equipment for heating and ventilating the bleach plant of the Minnesota and Ontario Paper Co. at International Falls, Minn., is described.

THE HEATING and ventilating equipment provided for the new bleach plant at the International Falls mill of the Minnesota and Ontario Paper Co., which went into partial operation in February, 1949, embodies a number of special features designed to cope with the severe weather extremes prevalent in that region, as well as to provide for the protection of personnel and equipment from the destructive gases encountered. This plant consists of a 100-ton, six-stage kraft bleachery, a 100-ton two-stage hardwood sulphite bleachery and provision for a single-stage 75-ton groundwood bleachery, together with caustic storage and bleach liquormaking facilities.

The bleach plant buildings are of structural steel and reinforced concrete construction with brick and tile walls, and consist of a five-story main bleachery building with a caustic storage building and a bleach liquormaking building as appurtenances. The main bleachery building is 68 feet wide, 119 feet long, by 90 feet high with a volume of 730,000 cubic feet. It contains four full floors, one partial mezzanine floor, and has a false ceiling at the bottom chord line of the roof trusses. The caustic storage building forms a south wing, completely open, to the main building, and is 42 feet wide, 85 feet long, by 44 feet high and has a volume of 160,000 cubic feet. The bleach liquor-
a south wing, completely open, to the main building, ing, but is isolated from it except for a normally closed fire door. It is 40 feet wide, 81 feet long, by 37 feet high, enclosing approximately 120,000 cubic feet.

The main building and caustic storage building have a combined volume of 890,000 cubic feet. The heating and ventilating equipment for these two structures consists of seven units which include electrostatic air filters, fin-tube steam heaters, activated carbon gas absorbers, and air-tempering recirculation systems. The bleach liquormaking building, being separate from the main building, has its own heating and ventilating system consisting of two units, together with an air-tempering recirculation system.

In the design of the main building, the washer or operating floor was planned to be pressurized and isolated from the remainder of the building to protect the personnel and equipment against exposure to toxic and corrosive gases (chiefly chlorine). This was accomplished by sealing off this space through the use of tightly fitting doors, special enclosures with air locks, and a more or less airtight cover over a large hatchway through which machinery and equipment could be hoisted from the ground floor through all the intermediate floors to the washer floor which is the top floor of the building.

The false ceiling at the chord line of the roof trusses (mentioned previously) was constructed of concrete, poured in place, and suspended by the trusses. The roof itself is of precast concrete slab construction covered with 2 inches of Insulite roof insulation and built-up roofing. There are eight openings in the ceiling, located directly above the lines of vacuum washers, fitted with anemostats for the introduction of air into the pressurized operating area from the space within the trusses which is, in effect, a huge plenum chamber, the length and width of the main building and approximately 7 feet high.

Outside air is furnished to this plenum chamber by heating and ventilating unit A which consists of an intake duct leading from an opening in the west exterior wall to an electrostatic air filter that is intended to remove small solid particles from the incoming air stream which then passes through activated carbon cannisters for the absorption of any undesirable gases such as fumes from the nearby acid plant.

The air flow is then divided equally between two identical distributing headers, each containing two double-bank fin-tube steam heaters and circulating fans. These fans discharge the cleaned and heated air directly without duct work into the plenum chamber in which they are located.

An air-tempering recirculation system is installed in the intake duct ahead of the electrostatic filters to prevent the formation of ice on the filter grids and to prevent the extremely cold air from freezing the first row of coils in the main heating banks. This recirculating system has an intake opening into the main intake duct just ahead of the filters. Air drawn into the preheater from this point is pased through two multibank steam heaters, identical to the two in the main system, and heated sufficiently to raise the temperature of the main incoming air about 55°F. The air flow in the recirculating system exhausts into the main intake duct some distance ahead of its intake to permit thorough mixing before entering the filters and heaters.

In addition to the recirculating system, the main heaters are further protected by an aquastat in the heater condensate discharge which, by means of a relay and solenoid coil, causes a weighted door located in the wall opening to block the inlet should the condensate temperature ever drop to 180°F. This protection is also provided for the heater banks in the recirculating systems.

Temperature control is maintained in both the main and preheating units by thermostats working in conjunction with regulating valves to throttle the 30-pound supply steam.

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The recirculating system is capable of handling 4700 c.f.m. and has a heat output of 700,000 B.t.u./hr. The main system has a capacity of 12,600 c.f.m. and an output of 1,500,000 B.t.u./hr.

The floor beneath the washer floor contains a tiled enclosure around the electrical equipment which consists of two large unit substations, six packaged type motor control centers, and sixteen speed variator motor-generator sets which generate direct current for the individual variable speed drives. This room also contains two air compressors supplying dry, clean air for instrumentation.

To protect this electrical equipment against dirt and corrosive gases and to insure a constant supply of clean air for the instruments, this tiled enclosure is pressurized by heating and ventilating unit B which is smaller but similar in arrangement to previously described unit A, consisting of an electrostatic air filter, activated carbon cannisters, a double-bank fin tube steam heater, and a single fan.

A preheating recirculation system, which draws air from the duct work ahead of the filter, heats it, and reinjects it at a point in the intake duct a short distance from the external wall opening, consists of a single double bank fin-tube steam heater and a circulating fan.

As described previously for unit A, temperature control for both the main and preheating systems is provided by a thermostatically operated regulating valve to throttle the 30-pound supply steam. This unit is also provided with freeze-up protection activated by a drop in the condensate temperature.

Air from the pressurized electrical control room is released to the surrounding area through four automatic louvres set in the tile wall. A portion of the air from this room is utilized as cooling air for the direct current variable speed motors located throughout the bleachery. Air for this purpose is removed from the pressurized room by ventilating unit C that consists of an electrostatic air filter and a circulating fan which discharges the air into a duct-work system leading to the casings of the direct current motors previously mentioned.

To prevent possible damage to the direct current motors because of overheating due to failure of the separate cooling system, the motor driving the unit C fan is electrically interlocked with the direct current equipment so that they cannot be operated with the circulating fan inoperative.

The recirculation system for unit B has a capacity of 6300 c.f.m. with a heat output of 600,000 B.t.u./hr. Main system for unit B will handle 8600 c.f.m. with a heat output of 700,000 B.t.u./hr. Motor cooling unit C filters and distributes 3600 c.f.m. of cooling air.

The remainder of the building is heated by a single large heating unit designated as unit D. Inasmuch as the purity of the air for this portion of the building is not critical, this system contains no filters or gas absorbers, however, a preheating recirculation system is provided to guard against excessively low incoming air temperatures freezing the heater coils. The recirculating system consists of a large double-bank fin-tube heater and a circulating fan with a capacity of 32,500 c.f.m. and a heater output of 2,800,000 B.t.u./hr. The reheat system includes a heater of equal size to the preheater plus a circulating fan with a capacity of 45,000 c.f.m. and a heater output of 3,300,000 B.t.u./hr.

Although the heated air discharged from this unit is released on the fourth floor, circulation is promoted by four 36-inch propeller type exhaust fans mounted in the exterior wall of the first floor which draw the air downward through the floor openings in the intermediate floors.

Three separate exhaust systems have been provided to exhaust water vapor and toxic and corrosive gases from their possible sources. Exhaust unit E consists of a duct-work system removing gases and vapor from the vacuum washers in the pressurized washer floor to which air is supplied by unit A previously described. The individual washers are provided with transparent plastic hoods with individual stainless steel and transite ducts connecting to the main exhaust headers which are also transite. Two such headers are provided, both terminating in a plenum chamber and exhausted by a fan with a capacity of 15,000 c.f.m. In addition to exhausting air from the washer hoods, this system also removes gas and vapor from all bleaching towers not containing corrosive gases.

The chlorination tower and the sulphur dioxide tower are vented by individual exhaust units F and G which consist of transite ducts feeding fans with capacities of 2000 c.f.m. each. All exhaust fans have a baked resin coating to prevent corrosion.

The bleach liquormaking building is heated by a single unit consisting of a circulating fan and a fin-tube heat exchanger. The heated air is discharged into a duct-work system with evenly spaced openings containing manual dampers for even distribution throughout the building. The air-tempering preheater consists of a circulating fan and a fin-tube heater arranged identical to that of the main unit.

The main system handles 9000 c.f.m. with an output of 650,000 B.t.u./hr. The recirculating system has a capacity of 6570 c.f.m. and a heat output of 550,000 B.t.u./hr.

Air from the bleach liquor building is exhausted by a single 36-inch propeller type exhaust fan mounted in the west exterior wall above the bleachmaking cells.

This complete heating and ventilating system was designed and furnished by the J. O. Ross Engineering Corp., who worked in collaboration with Hardy S. Ferguson and Co., consulting engineers and designers of the plant. All blowers and fans were manufactured by the B. F. Sturtevant Co., the activated carbon equipment by W. B. Conner Engineering Corp., and the electrostatic air filters by the American Air Filter Co.

Inasmuch as bleaching operations were started before the heating and ventilating systems were equipped with the air preheating facilities described, heating during the past season was done principally by temporary unit heaters provided during construction. Unit B, however, which pressurizes the electrical control room was operated using a temporary bleeding opening in the blower intake for drawing in room

air to temper the outside air on severely cold days. Unit C, furnishing cooling air for the direct current variable speed drive, was also operated as were exhaust units E and F.

It is expected that all equipment will be in operation this coming heating season, and it is anticipated that the interior of the bleachery and bleach liquormaking building will be safe and comfortable for operating personnel despite outdoor temperatures ranging to 40° below zero and the prevalence of toxic and corrosive gases originating both within the building and in the area immediately surrounding it.

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Aluminum Chloride as an Alum Substitute

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Aluminum chloride has not been employed heretofore on a commercial scale for the setting of rosin size because it is much more expensive than alum. However, aluminum chloride is widely used in the chemical and petroleum industries and is potentially available as a byproduct from many operations in the form of a concentrated aqueous solution suitable for use in papermaking. Such an aqueous aluminum chloride has been used in extended mill trials on a cylinder machine making a variety of kraft specialties. The degree of sizing obtained was equivalent in every respect to that ordinarily obtained with alum, there was no resultant change in the operation of the paper machine, nor was there any unusual corrosion of machine parts. There were two important improvements which resulted from the use of aluminum chloride in place of alum: (1) the color of the product was much better, and (2) the efficiency of the melamine resin used for abrasion resistance and wet strength was so markedly improved that 1% gave essentially the same results as ordinarily obtained with $2^1/_2$% in the presence of alum.

FOR MANY YEARS there has been a division of opinion amongst papermakers as to whether alumina or the aluminum ion was the effective agent in setting or attaching the rosin size onto the fibers in the papermaking furnish. Several recent publications have shed considerable light on this much discussed but poorly understood subject.

In 1944, Redd (*4*) found that alum was much more efficient than alumina in accomplishing the sizing of pulp with rosin. He concluded that the presence of free aluminum ions, furnished by the alum, was responsible, at least in part, for the sizing obtained.

More recently Price (*5*) found that alumina, as it occurs in papermaking from sodium aluminate, or other sources, is detrimental to sizing. Its presence lowered sizing test values obtained by the news ink test considerably.

A method was developed by Price (*6*) for determining alumina in wet rosin size precipitate floc. Use of this method showed that a standardized size precipitate contained no appreciable amount of alumina, thus demonstrating that the aluminum ion, rather than alumina, was necessary for the formation of an effective rosin size precipitate.

Price (*7*) has also shown that a material of the composition of aluminum diresinate can be isolated from either sized papers or from size precipitate.

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ALUMINUM CHLORIDE AS A SIZE SETTING AGENT

These findings naturally lead to the assumption that other aluminum salts, such as aluminum chloride, might be effective in furnishing aluminum ions for setting rosin size on pulp fibers. That such is possible was pointed out as far back as 1920 in a German patent (*2*) which states that aluminum chloride solutions have a higher alumina content than aluminum sulphate and produce in the pulp quite as good an alumina-resin precipitate as the sulphate, so that they may be used as substitutes for the latter in rosin sizes.

More recently Duston (*1*) has pointed that in laboratory tests aluminum chloride has been found to have an effect similar to that of alum in sizing paper with rosin.

A patent issued to F. W. Boughton (*8*) describes and claims the combination of aluminum chloride and melamine resin for high-wet strength in photographic base paper.

The reason that aluminum chloride has not been used more widely for sizing paper is a simple matter of economics. The present market price of aluminum chloride is about three and one-half times that of ordinary papermaker's alum at equivalent aluminum oxide contents.

In spite of this discouraging fact, one should not forget that aluminum chloride, anhydrous and otherwise, is an industrial chemical having manifold uses. One of the largest and most varied of these uses is as a catalyst in certain organic reactions. Frequently after the activity of such a catalyst has been spent, it is decomposed by hydrolyzing or dissolving it in water and then discharging it to the sewer. Such aqueous solutions are a potential source of aluminum chloride for the pulp and paper industry, and the profitable use of such byproducts can be of mutual advantage to both industries.

In 1945, some 69,000,000 pounds of aluminum chloride were consumed in the United States. If half of this aluminum chloride were available to the pulp and paper industry, it would be equivalent to approximately one-third of the alum demand of the southern kraft industry, 1 pound of anhydrous aluminum chloride being equivalent to about $2^1/_4$ pounds of papermaker's alum.

At Monsanto Chemical Company's Texas City plant, anhydrous aluminum chloride is employed as

the catalyst in the alkylation of benzene with ethylene, the ethylbenzene so produced being subsequently dehydrogenated to styrene. In the alkylation system, the aluminum chloride is present in combination with aromatic hydrocarbons in the form of a dense liquid commonly referred to as catalyst complex. This liquid is the active catalytic agent. When its catalytic properties have been spent, it is decomposed by hydrolysis with water. From this hydrolysis step the aluminum chloride is available as a concentrated aqueous solution of pale yellow color having a concentration of 20 to 30% $AlCl_3$, or 7.6 to 11.4% Al_2O_3. Production of the aqueous aluminum chloride is estimated to be about 20,000 gallons per month, or enough to supply the demands of the cylinder machine at Southland Paper Mills. The aqueous aluminum chloride usually contains small amounts of aromatic hydrocarbons, generally less than 200 p.p.m. as ethylbenzene. This organic content has not been found to be injurious in the application herein described.

MILL TRIALS

Aqueous aluminum chloride made by the process described above was tested in the laboratories of Southland Paper Mills, first in gallon, and then in carboy quantities. These tests indicated that it was equivalent to alum for sizing paper and led to mill scale trials with tank car quantities.

The machine on which the aluminum chloride was run is a five-vat cylinder machine trimming 108 inches. A variety of kraft specialties are run on this machine including bleached liners as well as full unbleached sheets. Some of the specialties include various amounts of groundwood.

A rubber-lined tankcar containing the aqueous aluminum chloride was spotted at a loading platform some 200 feet from the machine. The solution was forced through a rubber hoseline to the cylinder machine chest by padding the car with air. The regular alum system feeding the machine consists of a Leeds & Northrup pH recorder and controller by which the alum is fed through a motor-operated valve. To feed the aluminum chloride, a suitable T-connection was made in front of this valve, the alum was merely cut off, and the aluminum chloride was introduced to the valve. The pH controlling mechanism closed the valve somewhat to compensate for the stronger solution, after which it continued to function normally.

At the time the switch-over was made, a 52-pound, 15-point liner sheet was being run which contained a small portion of groundwood. The pH in the machine chest was run at 4.3. It was necessary to run the pH this low at that point to compensate for the high alkalinity of the fresh water vat showers. The pH in the vats themselves was approximately 5.5.

Careful observation was made of all the machine operating conditions, and when the aluminum chloride had worked into the systems, no difference in the sizing of the sheet was noticed. Heads in the vats remained the same, and, although a careful watch was kept on the draw at the stack, no change was discernible. One starch box on each side of the sheet was being employed at that time as well as on all of the other grades on which the aluminum chloride was run. The sheet density, as measured by the relations between basis weight and caliper, remained the same as when regular alum was used in the sheet.

One improvement that was attributed directly to the use of the aluminum chloride was a much better color of the sheet. The regular alum is purchased in liquid form at approximately 8% aluminum oxide content and contains around 0.4% iron salts as Fe_2O_3. As the aluminum chloride contained practically no iron the resulting sheet was a clear, golden yellow compared to a rather murky brown when the regular alum was used.

The following table shows the tests of the various sheets as run during the $3^1/_2$ days during which the aluminum chloride was used. The first two grades contain small portions of groundwood, while the last two are 100% unbleached kraft sheets. The penescope tests were run in the standard penescope instrument using 20% lactic acid. The test values for these same grades in which the regular alum was used are so close that they do not warrant repetition in a separate table.

Basis weight, lb./1000 sq. ft.	*Moisture, %*	*Caliper, in.*	*Bursting strength p.s.i.*	*Penescope, min.*	*Absorption*[a]
52	5.6	0.0152	105	9.0	593
51	6.1	0.0135	117	9.3	529
91	5.5	0.0243	189	35.8	491
61	5.9	0.0155	151	29.3	478

[a] Increase in weight in grams multiplied by 100 of a 6- by 6-inch sample which has been immersed in water for 10 minutes.

During the $3^1/_2$-day run on these four grades, 41,000 pounds of aluminum chloride solution at 6.5% Al_2O_3 content was used. This was equivalent to about 800 pounds of aluminum oxide or 4700 pounds of 17%-Al_2O_3 papermaker's alum per day. At the production rates at which the machine was run, this is equivalent to 75 pounds of papermaker's alum per ton of board. Here again, the comparison of the aluminum chloride to the regular alum in terms of chemical consumption is so close that a listing in a table is hardly worthwhile.

A second car of aluminum chloride had a somewhat higher concentration of aluminum oxide and was used on the machine for 5 days while running bleached specialties. Operating conditions were so similar to those when regular alum was run that it is felt sufficient merely to summarize by saying that no essential difference could be noted.

A portion of this last car was reserved for a 75-ton order of 100% unbleached kraft sheet of 22 points caliper and approximately 85 pounds basis weight. This sheet was treated with Parez 607 melamine resin, and a close study was made to substantiate the effect of the sulphate ions on the melamine resin as reported by Maxwell and Reynolds (*3*). The laboratory work of these two authors indicated that the sulphate ion was the only one seriously interfering with the resin as compared to the effect of other ions including the chlorides. The white water of this cylinder machine normally contained 450 p.p.m. sulphate ions in the vat when regular alum was run compared to only 40 p.p.m. when the aluminum chloride was run. The

chloride ion concentration in the vats averaged 230 p.p.m. while the aluminum chloride was used.

Some quite remarkable results were achieved during this trial in that the efficiency of the resin was increased insofar as the abrasion resistance of the sheet was concerned, to a point where 1% melamine resin had the same effect when aluminum chloride was used that $2^1/_2$% melamine resin had when the regular alum was used. The Taber Abrasion Tester, using an H-18 wheel, was used to evaluate the dry abrasion resistance of the sheet, the average range of values being from 850 to 1000 wear cycles. This range of values applied to both the $2^1/_2$% resin-regular alum combination, and to the 1% resin-aluminum chloride combination. The same tests on a comparable sheet with no resin would run approximately 300 wear cycles. There were some spot tests made during the resin-aluminum chloride combination that ran as high as 2000 wear cycles.

Wet bursting strength tests made after soaking in water for 24 hours gave values which averaged 38% of the dry bursting strength for the sheet made with 1% melamine resin in the presence of aluminum chloride. When 2% resin was used in the presence of regular alum, the wet bursting strength averaged about 42% of the dry value. This slight difference indicates that 1% melamine resin in the presence of aluminum chloride is as effective as 2% in the presence of alum.

After the mill trials with aluminum chloride substituted for alum, inspections were made of cylinders, vats, drier rolls, and other machine parts to determine whether any evidence of unusual corrosiveness existed. None could be found. Laboratory tests have indicated that the aqueous aluminum chloride solutions are no more corrosive than alum solutions of similar concentration.

These mill trials have resulted in the sale and regular shipment of concentrated aqueous aluminum chloride from Monsanto's Texas City plant to Southland Paper Mills. The price established for the aluminum chloride placed it in a competitive position with papermakers' alum in view of various local factors involved.

CONCLUSIONS

Considerable quantities of aluminum chloride are potentially available from the chemical and petroleum industries as a byproduct. This aluminum chloride can be had from many operations in the form of a concentrated aqueous solution suitable for use in pulp and paper manufacture. In this application it is an efficient substitute for alum.

Mill trials have been made with such an aqueous aluminum chloride solution on a cylinder machine making a variety of specialties. Not only was the aluminum chloride a satisfactory substitute for alum, but some pronounced advantages were obtained by the use of this size setting agent. The color of the sheet was appreciably benefitted, and the efficiency of the melamine-formaldehyde resin used for abrasion resistance and wet strength was improved tremendously.

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A Method for Comparing the Wet-Rub Resistance of Coated Papers

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A method for camparing the wet-rub resistance of coated papers is presented which is rapid, adaptable to a wide range of coatings, and which utilizes readily available, inexpensive equipment.

With the increased interest of the paper industry in paper and board coatings, several methods have been developed for obtaining the improved water or wet-rub resistance often necessary in the coated sheet. To measure this characteristic, there are in use several methods which have widely varying degrees of accuracy and convenience and some of which are highly susceptible to slight technique variations.

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For several years we have used in this laboratory a relatively simple procedure for evaluating the wet-rub resistance characteristic of paper coatings which utilizes simple equipment, is rapid and consistent, and may be easily adapted to measure a wide range of coatings. It is perhaps crude in many respects but has been found adequate for the comparison of most samples.

EQUIPMENT AND PROCEDURE

It comprises rubbing an immersed coated test sample with a soft bristle brush for a measured time and with a measured pressure. The coating solids removed are decanted and then estimated with a simple turbidimeter or nephelometer. As the immersion time, rub-

bing time, speed, and pressure may all be varied, the method can easily be adapted to a wide range of coatings.

Apparatus

The rubbing medium suggested is a small shaving brush with the bristles trimmed to a uniform length. It is attached to a wooden disk, as shown in Fig. 1, so that its center turns in a circle approximately 2 inches in diameter. The disk in turn is mounted on the shaft of a small ($^1/_{30}$-h.p.) geared-head electric motor which turns the disk and brush at 40 r.p.m.

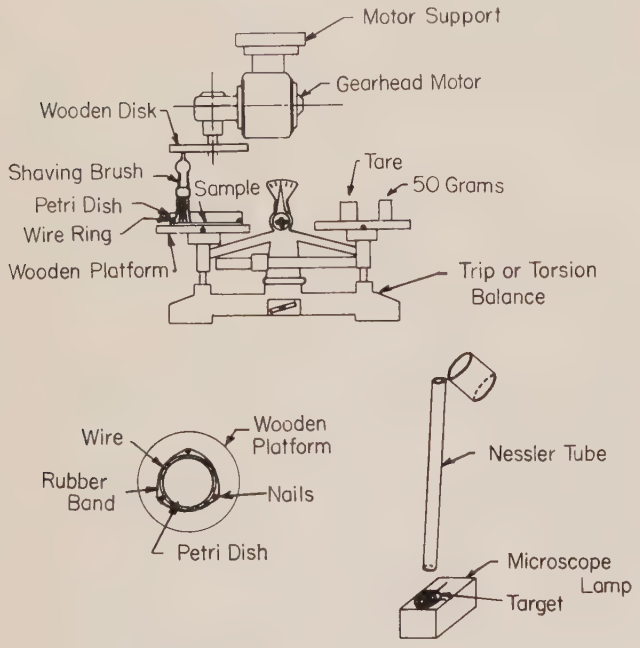

Fig. 1

A constant measured pressure of the brush on the sample is maintained by supporting the sample on one pan of a torsion or trip balance and adjusting the weights to give the desired pressure. A disk of the sample to be checked is cut to fit a 9-cm. ($3^1/_2$-inch) glass Petri dish which is held firmly on one balance pan. It has been found convenient to replace one of the balance pans with a wooden disk into which are driven three or four small nails near the periphery of the dish. Looping a single wide rubber band around the nails and dish effectively prevents it from shifting and allows its easy removal. The test sample is in turn held in the dish with a loop of solder or other heavy wire placed near the edge of the paper.

Procedure

Twenty-five milliliters of water are poured on the sample in the mounted dish and the balance is tared to balance the sample, dish, wire, rubber band, and water. A 50-gram weight is then placed on the opposite pan which causes the sample to press against the brush with the same pressure. The balance (or brush) height is then adjusted so the balance pointer reads zero with the above weights in place.

The usual test consists of 1 minute or 40 circular rubs of the brush after which the balance pan supporting the sample is depressed, the brush is gently squeezed to remove excess water, and the Petri dish is removed. The water now containing the removed coating solids is poured into a beaker as are an additional 75 ml. of water used to flush off the surface of the rubbed sample.

The suspended solids are then estimated by the use of a simple turbidimeter consisting of a 100-ml. (2-cm. diameter) Nessler tube with a flat polished bottom and a small laboratory substage microscope lamp having a target inked on transparent paper inserted under the ground glass. The Nessler tube is held over the target and the mixed water portions above are poured slowly into the tube until the target is just obliterated. The height of the liquid column necessary for the target extinction is then measured in centimeters. The extinction height determination is repeated until two values are obtained agreeing within $^1/_2$ cm., and after a little practice the observer can usually obtain this agreement in the first two attempts.

Usual starch-clay coatings tested as above give extinction heights of 0.5 to 5.0 cm. depending in part on the basis coating weight. With similar coatings designed for improved wet-rub resistance the target may still be clearly visible at the equipment maximum limit of 30 cm. of test liquor. In such cases the test may be modified by lengthening the rubbing period, soaking prior to rubbing, etc., but usually such measures are not necessary as differences between coatings testing beyond this range are relatively meaningless. Similarly at extinction heights of below 2.0 cm. a measured dilution of the test liquor magnifies differences between coatings, but here also such differences in this range are not believed significant.

Holding the Nessler tube at a slight angle from the vertical enables the pouring of the test solution down the wall of the tube with consequent less distortion from entrained air and facilitates the end point determination.

A variety of other turbidimetric methods are available and a few were tried for this purpose. The above method was adopted because of its simplicity, use of inexpensive equipment, and adequate accuracy.

EVALUATION OF COATINGS

By determining the extinction height for a number of different dilutions of a given clay coating color it was found that when plotted on a log-log paper (concentration vs. extinction height) approximately straight lines result. This was also found true for different dilutions of the suspension of a clay coating removed by the above wet-rub technique. However, the slope of the latter when plotted is slightly different than that of the former, possibly because of a slight difference in particle size between the original coating color and the suspension of the removed coating particles. For practical purposes this difference is believed negligible.

Using the above relationships it is an easy matter to estimate the relative solids content in the liquid suspensions resulting from the wet-rub test as described and to use this as a basis for comparing the wet-rub resistance of various coatings.

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A New Method of Isolating Conidendrin from Sulphite Waste Liquor

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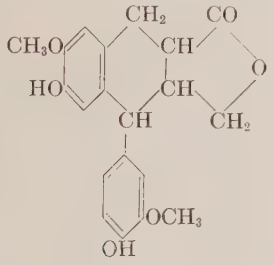
A method of obtaining conidendrin by precipitation from sulphite waste liquors has been found. This procedure is carried out by mixing with the waste liquor a small amount of one of several organic liquids, and allowing them to stand. After decantation of the waste liquor the solid conidendrin is removed by filtration. The advantages of this procedure are that a large volume of liquor may be treated in simple apparatus, and a relatively pure product is obtained. The practicality of this method of obtaining conidendrin has been demonstrated in a small semiworks plant. Variables involved in the procedure such as the effect of concentration, temperature, amount of SO_2, and pH of the waste liquor have been studied. A survey of organic compounds satisfactory for carrying out the precipitation was made and the amount of precipitant necessary to obtain maximum yields was determined for the best precipitant, trichloroethylene. Although conidendrin itself has not yet been found of industrial value, derivatives of it have shown promise as commercial antioxidants and for pharmacological uses.

CONIDENDRIN is a phenolic wood extractive found in many species of coniferous trees, including spruce, fir, and hemlock (*3*). During the sulphite pulping process the conidendrin is dissolved and held in solution in the sulphite waste liquor.

As a complex, naturally-occurring substance containing hydroxyl, methoxyl, and lactone groups, conidendrin has attracted attention for many years since its original discovery by Lindsey and Tollens (*10*) in 1892. It was known first simply as sulphite waste liquor lactone, was characterized independently as Tsugaresinal (*9*), and has been called conidendrin after these two were proved identical. Various attempts to elucidate the structure were unsuccessful until Erdtman (*2*) proposed the correct structure and Haworth (*5, 6*) proved it by synthesis.



Interest in the problem of obtaining conidendrin from sulphite waste liquors was aroused by the report of Pearl (*11*) that liquor from the pulping of western hemlock (*Tsuga heterophylla*) was especially rich in conidendrin.

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Reported methods of isolating conidendrin have uniformly consisted of lengthy extraction of waste liquor by ethers, benzene, or halogenated hydrocarbons (*4, 7, 9, 10, 11*). A variety of equipment, ranging from separatory funnels to elaborate liquid-liquid extractors has been employed. With any of the equipment and all of the solvents used, complete extraction has been of several hours duration because of the insolubility of conidendrin in the extracting liquid. The product has usually been contaminated by various wood extractive materials.

When carrying out routine extractions of sulphite waste liquor, the authors discovered that conidendrin could be precipitated by the selective action of various organic liquids. This was accomplished by adding to the waste liquor a small amount (0.25 to 10% by volume) of the organic liqiud The mixture was agitated thoroughly to achieve a complete dispersion of the liquids in each other and was then allowed to stand for several hours. The liquids formed two phases with a precipitate of solid conidendrin either at the liquid-phase boundary or at the bottom of the container. The solid conidendrin was then readily removed by filtration.

The simplicity of the operation and the fact that up to 90% as much conidendrin was obtained by precipitation as was isolated by 8 hours continuous extraction of the same liquor with various solvents aroused interest in the procedure. Further experiments were made to determine the optimum conditions.

EXPERIMENTAL PROCEDURE

A standard precipitation of conidendrin was carried out in the following manner: Two liters of filtered sulphite waste liquor from the pulping of hemlock wood was cooled to room temperature. The liquor was placed in a 5-liter round bottomed flask with 40-ml. trichloroethylene. The mixture was stirred for 30 minutes with a high-speed stirrer. The resulting milky dispersion was allowed to stand overnight. There was then visible a clear reddish-brown waste liquor layer, and a clear slightly yellow layer of trichloroethylene. Between them was a cream-colored deposit of solid particles. The aqueous top layer was removed by siphoning and the remainder of the liquid was passed through a Buchner funnel. The precipitate was washed with water and dried, giving a white powder identified as conidendrin by its melting point 251 to 255°C. (*11*).

All data presented have been derived from work with waste liquor from the pulping of western hemlock (*Tsuga heterophylla*). The only other waste liquor available for study has been that from white fir (*Abies concolor*). No conidendrin was obtained from this

Table I. Effect of pH on Quantity of Conidendrin Precipitated[a]

pH	*Conidendrin, g./l. sulphite waste liquor*
0.50	0.50
1.50	0.66
2.75	0.66
3.78	0.50
4.62	0.51
5.43	0.52
8.50	0.20
9.54	0.13

[a] One-liter samples of waste liquor were adjusted to the given pH by NaOH or HCL and treated with 20 ml. trichloroethylene by the standard procedure.

white fir liquor. Furthermore, white fir liquor in hemlock liquor of known conidendrin content inhibited the precipitation of this conidendrin. After this had been demonstrated, work on white fir liquor was discontinued.

The pH range for optimum precipitation was investigated (see Table I.). It was found that the largest yields of precipitated conidendrin coincided with the pH range of untreated waste liquor. Above a pH of 7 the yields fell off due to formation of the sodium salt of the free acid as the lactone ring opened. Also at a high pH the liquor became dark with a slight precipitation of metallic salts. Agitation with trichloroethylene accelerated the precipitation of these salts.

Concentration of the liquors by evaporation did not result in a larger yield of conidendrin. Instead, approximately the same yields were obtained, but the conidendrin was precipitated with a large amount of calcium salts. Addition of water up to 25% of the original liquor volume did not reduce the yield when calculated on the basis of the amount of waste liquor used. Table II summarizes these results.

The temperature affected the speed and form of precipitation more than the ultimate yield of conidendrin. At any temperatures between the freezing and boiling points of the liquids involved, some conidendrin was precipitated. In the 5 to 60°C. range there was no appreciable difference in the total amount of conidendrin precipitated.

The presence or absence of free sulphur dioxide in the liquor had no appreciable effect on the amount of conidendrin precipitated. This was demonstrated by obtaining essentially the same amount of conidendrin from a liquor when either saturated with sulphur dioxide or when boiled to remove all dissolved gas.

In addition to these sources of variation in yield of conidendrin, there were others of unknown character which accounted for widely different yields. These variations were noticed from batch to batch of waste liquor and were present even when the method of isolation of conidendrin was identical. Attempts were made to correlate the yields obtained with such factors as the area of origin; average age, and rate of growth of the trees; whether they were alive or dead, dormant or growing when cut; and the elapsed time between cutting and processing. Also considered were the variations in cooking conditions such as acid concentration, time of cooking, and ultimate temperatures and pressures reached. No definite conclusions could be established from the limited number of samples studied.

Table II. Effect of Dilution of Waste Liquor on Conidendrin Yield[a]

Volume sulphite waste liquor, ml.	*Volume water, ml.*	*Amount water added, %*	*Amount solids, %*	*Weight conidendrin precipiated, grams*	*Conidendrin, g./l. sulphite waste liquor*
5000	0	0	11.2	2.85	0.57
4674	326	7	10.5	2.65	0.57
4303	697	16.2	9.7	2.30	0.53
3982	1018	25.6	9.0	2.30	0.58

[a] Each sample was treated in a standard manner with 100 ml. trichloroethylene.

The type of organic liquid used to precipitate conidendrin had a great effect on the efficiency of the procedure. Although the precipitation was first noticed with trichloroethylene, it was soon determined that the same result was obtained with many classes of organic compounds. A large number of experiments was carried out to determine the best precipitants.

In each case, 1-liter samples of waste liquor were treated with 20 ml. of the organic liquid. If the liquid had a greater density than waste liquor it was treated in the standard manner. If the density was less than waste liquor, the agitation was carried out in a 2-liter separatory funnel. After the settling period the aqueous portion was removed and the remainder filtered. The precipitates were identified as conidendrin by the m.p. 250 to 255°C. or the m.p. of the acetates 220 to 223° (*1*).

Among the best precipitants were trichloroethylene, toluene, and methyl isobutyl ketone. Members of the following classes of organic compounds precipitated varying amounts of conidendrin, ranging from barely enough for identification to nearly as much as given by the best precipitants: aromatic hydrocarbons, halogenated hydrocarbons, carbonyl compounds, ethers, esters, nitro compounds, and some fatty acids. Classes of compounds which did not precipitate conidendrin included: aliphatic hydrocarbons, amines, alcohols, and phenols. Various miscellaneous compounds such as carbon disulphide and liquid mercaptans did not precipitate conidendrin.

Table III. Organic Precipitants for Conidendrin

Hydrocarbons:	Ethers:	Carbonyls:
Benzene	Ethyl	Methyl isobutyl ketone
Toluene	β,β′-Dichloro ethyl	Diisobutyl ketone
Xylene	*n*-Propyl	Mesityl oxide
Diphenyl methane	Isopropyl	Butyraldehyde
Diphenyl	*n*-Butyl	Furfural
Dipentene	*n*-Amyl	Benzaldehyde
	Isoamyl	*o*-Chlorobenzaldehyde
	Eugenol	
	Guaiacol	
Halogenated Hydrocarbons:	**Nitro Compounds:**	**Esters:**
Methylene chloride	Nitromethane	Ethyl acetate
Chloroform	Nitroethane	Ethyl malonate
Carbon tetrachloride	2-Nitro propane	Ethyl acetoacetate
Ethylene chloride	Nitrobenzene	Ethyl salicylate
Trichloroethylene	**Acids:**	Ethyl succinate
Perchloroethylene	*n*-Caprylic	Ethyl benzoate
Chloropropane	Oleic	Isoamyl salicylate
Bromobenzene		*n*-Amyl propionate
Chlorobenzene		
Bromobenzene		
n-Propyl bromide		
Methyl iodide		

Table IV. Effect of Variations in Amount of Trichloroethylene used to Precipitate Conidendrin

Trichloroethylene, ml./l. sulphite waste liquor	*Conidendrin, g./l. sulphite waste liquor*
1	0.09
2	0.14
8	0.43
10	0.43
15	1.09
18	1.17
21	0.88
25	0.69

All precipitants have been characterized by being nearly insoluble and nonreactive in waste liquor and by being poor solvents for conidendrin. Table III summarizes this information.

On a laboratory scale the completeness of precipitation has been dependent on the ratio of amount of precipitant to amount of waste liquor (see Table VI). With trichloroethylene the optimum precipitation was obtained with approximately 2% trichloroethylene by volume in the mixture. When the scale of the experiment was expanded to use several hundred gallons of waste liquor it was found possible to reduce the amount of trichloroethylene to as little as 0.5% by volume while maintaining satisfactory precipitation.

The purity of the product was dependent on the condition of the waste liquor and on the technique of isolation, but in nearly all cases was greater than that of conidendrin obtained by solvent extraction.

In the work reported the waste liquor was filtered or allowed to settle to eliminate pulp fibers. If present, these were precipitated with the conidendrin. In addition to any pulp present the conidendrin contained a small amount of colored material. Both of these contaminants were removed by recrystallization from acetone or methanol. The average precipitated conidendrin, without further treatment, was a white or light gray powder containing less than 2% impurities.

Some portion of the lignin present seemed to be the solubilizer for conidendrin in waste liquor. This was based on the inability to dissolve more than 0.1 gram conidendrin per liter in water, a 2.5% sugar solution, or in a saturated water solution of the colored materials extracted from waste liquor by trichloroethylene. The solubilizer was not removed from the liquor by treatment with trichloroethylene or by steam distillation. On the other hand, a solution of calcium lignin sulphonate did dissolve an appreciable quantity of conidendrin.

A 3.5-liter portion of waste liquor was treated with 70 ml. trichloroethylene in the standard manner. From it 1.7 grams conidendrin was obtained. The aqueous liquor was steam distilled to remove the trichloroethylene and heated with 5.0 grams conidendrin; 1.3 grams were dissolved, and the remainder was removed by filtration. Another treatment of the liquor with trichloroethylene resulted in the precipitation of 0.9 grams conidendrin.

Two liters of a hot 10% Howard lignin solution in water dissolved 0.7 grams conidendrin. On cooling, no conidendrin precipitated out, but stirring with 40 ml. trichloroethylene gave 0.3 grams.

No satisfactory explanation has been found for the precipitation of conidendrin from sulphite waste liquor by these organic liquids. It is possible that the precipitant dissolves sufficiently in the liquor to decrease the solubility of conidendrin. That the liquor does not merely hold conidendrin in a supersaturated solution was demonstrated by seeding waste liquor with conidendrin. Very little more precipitate formed after three weeks.

CHARACTERIZATION OF PRODUCT

Conidendrin isolated in the manner described was characterized by comparing its physical properties and derivatives with literature citations as shown below:

Compound	*M.p. recorded, °C.(1)*	*M.p. found, °C. (uncorr.)*
Conidendrin	255–256	255–256
Conidendrin diacetate	222–223	220–223
Conidendrin ditosylate	195–196	193–195
Dimethyl conidendrin	179–180	179–180

The best laboratory procedure using trichloroethylene has been operated successfully in a small semiworks plant. This plant has produced about 1 pound of conidendrin per day for several months. This successful operation has demonstrated the practicality of the precipitation method for obtaining conidendrin from sulphite waste liquor.*

For larger scale operation many engineering improvements are possible. For example, proper design would allow continuous operation. By suitable steam-stripping equipment, the recovery of trichloroethylene could be increased to nearly 100%, a very important consideration in the economy of the process. Plans have been drawn for the construction of a pilot plant incorporating these improvements and it is expected that such a plant will be in operation in the near future.

Although uses for conidendrin itself have not been found to date, derivatives of it have shown considerable promise as valuable industrial chemicals. New procedures have been found for preparing the product made by Holmberg (*8*) through the action of sodium ethoxide on conidendrin. This substance, a steric isomer of conidendrin, has appeared promising as a nonstaining antioxidant for rubber. Demethylated products of conidendrin have been found to be excellent antioxidants for oils and paraffin. They have also shown bacteriostatic activity against certain pathogens. Further testing of these conidendrin derivatives is in process.

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* A patent application for the procedure has been accepted by the U. S. Patent Office.

Paper Mill Turbine Selection

J. C. SPAHR

As fuel costs increase it is more important than ever to select the right turbine for the job. This can be done if the turbine is selected on the basis of a thorough knowledge of the plant requirements. Plant analysis similar to that illustrated is of utmost importance in obtaining a successful turbine installation. Further savings in fuel costs are made possible by the application of feedwater heating cycles. Satisfactory operation on a modern industrial turbine depends almost entirely on the control system. The control system illustrated clearly shows that practically any type of operating requirements can be satisfied automatically by the turbine. The opportunities for reduced plant costs resulting from standardization should be given full consideration. In this connection technical associations such as TAPPI with the assistance of the manufacturers should take the lead in establishing the standards.

THE INDUSTRIAL turbine users of today have available turbine equipment to satisfy practically any operating requirements.

The types range from the straight condensing unit generating electrical power only to the mixed pressure, double automatic extraction units which automatically control speed and process steam pressures at the same time. These turbines, however, can operate satisfactorily only within their designed limits. It is therefore necessary to accurately determine the plant requirements with a reasonable allowance for future expansion before it is possible to make the proper turbine selections. With the requirements known the paper mill engineer can determine the size and type of the unit or units which are best suited for his particular plant. While each paper mill engineer has his own particular problems to consider there are several major objectives which should guide the selection in all

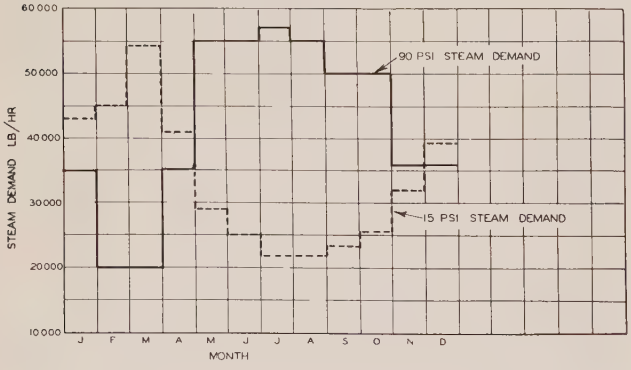

Fig. 1. Combined process steam demand to be supplied from turbine

paper mills. First, the generation of process steam and electrical power at a minimum fuel cost. Second, an installation which will permit maximum freedom to obtain process steam and electrical power as desired. Third, dependable operation at all times. The procedure for selecting the turbine installation which will meet these requirements is the same regardless of the mill involved whether new or old although the results of course will probably differ for each mill.

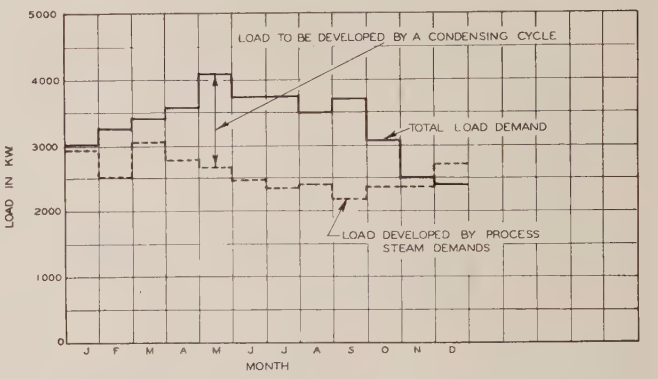

Fig. 2. Power load demand curve showing division between process steam and condensing cycle

It is an accepted fact that when both process steam and electrical power are required, the most economical operation is obtained when the byproduct power is at a maximum. The important point is to have a thorough knowledge of the plant requirements as a basis for selecting the turbine equipment which will give the maximum byproduct power.

STEAM AND POWER DEMANDS

Plant studies should result in process steam demand charts similar to that shown by Fig. 1. In this instance process steam is required at both 90 and 15 p.s.i. The electrical load demand for the same period of time is shown by the full line on Fig. 2. For the examples in

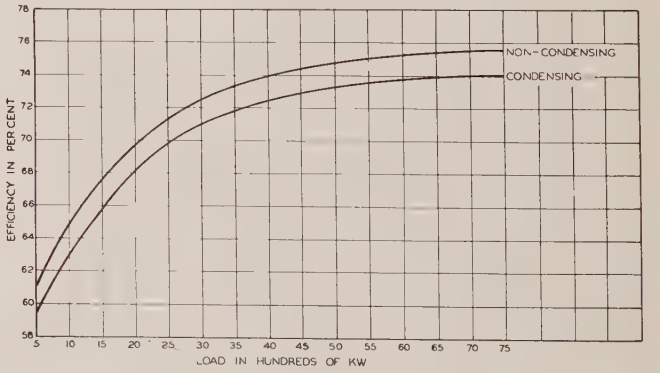

Fig. 3. Approximate Rankine cycle efficiency ratios of turbo-generators

Figs. 1 and 2 the inlet steam conditions were established at 400 p.s.i. at 175°F. superheat. With the inlet steam conditions, process steam flows and process steam pressure known, the electrical power developed from process steam can be determined. The load developed

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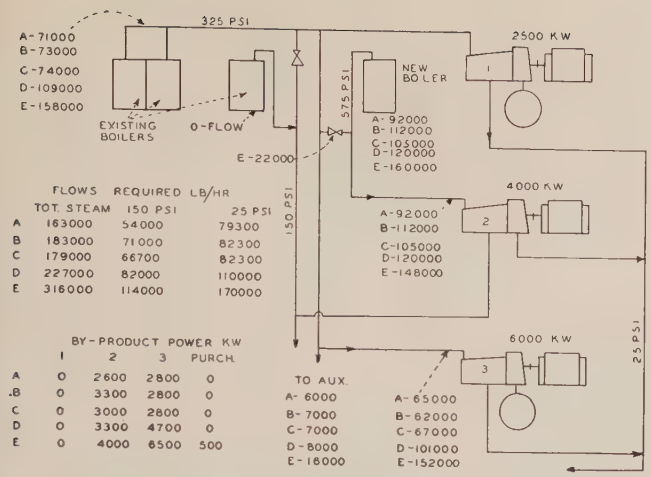

Fig. 4. Flow diagram for P. H. Glatfelter plant

depends on the steam flow, available energy, and the efficiency of the unit. Figure 3 shows the approximate efficiency of both the condensing and noncondensing turbine-generator units from 500 to 7500-kw. ratings. Final performance on the turbine selected must be obtained from the manufacturer. Choosing a rating at random for efficiency on the first trial all the factors are known to calculate the electrical load developed.

The available energy is obtained from the steam tables or steam charts. From the steam charts it is found that the enthalpy drop from inlet to the process steam pressures are 133 B.t.u. to the 90 p.s.i. point and 228 B.t.u. to the 15 p.s.i. pressure. Assuming a 2500-kw. noncondensing unit for the first trial the efficiency is found to be 71.3, therefore, $133 \times 71.3 = 95$ B.t.u./lb. converted into work for 90 lb. steam and $228 \times 71.3 = 162.7$ B.t.u./lb. converted into work for 15 lb. steam.

Since 3413 B.t.u. are the equivalent to 1 kw.-hr., the pounds of steam per kilowatt hour are: $3413/95 = 35.9$ lb. per kw.-hr. for 90 p.s.i. steam; $3413/162.7 = 21$ lb. per kw.-hr. for 15 p.s.i. steam. Knowing the steam rate in pounds per kilowatt hour the byproduct power can be determined and plotted against load demand as shown in Fig. 2.

It will be noted that at no time during the year does the byproduct power balance the electrical load demand. This is the usual situation and for a satisfactory installation a source of firm power must be provided to supply the difference between load demand and byproduct power. The source of firm power depends on whether the plant has a tie-line available to a public utility or whether it is entirely independent, in which case the firm power is produced by condensing units. These units may be either the straight condensing type or as in the majority of cases the condensing end of an automatic extraction type turbine. Many plants find it advantageous to provide both sources of firm power using the tie-line for the most part as a standby.

Recent studies of the plant requirements of the P. H. Glatfelter Co. plant, Spring Grove, Pa., resulted in the installation of a 4000-kw. noncondensing single automatic extraction unit and a 6000-kw. condensing single automatic extraction unit. The 4000-kw. unit operates on 575 p.s.i. 625°F. inlet steam conditions, extracting automatically at 150 p.s.i. and exhausting

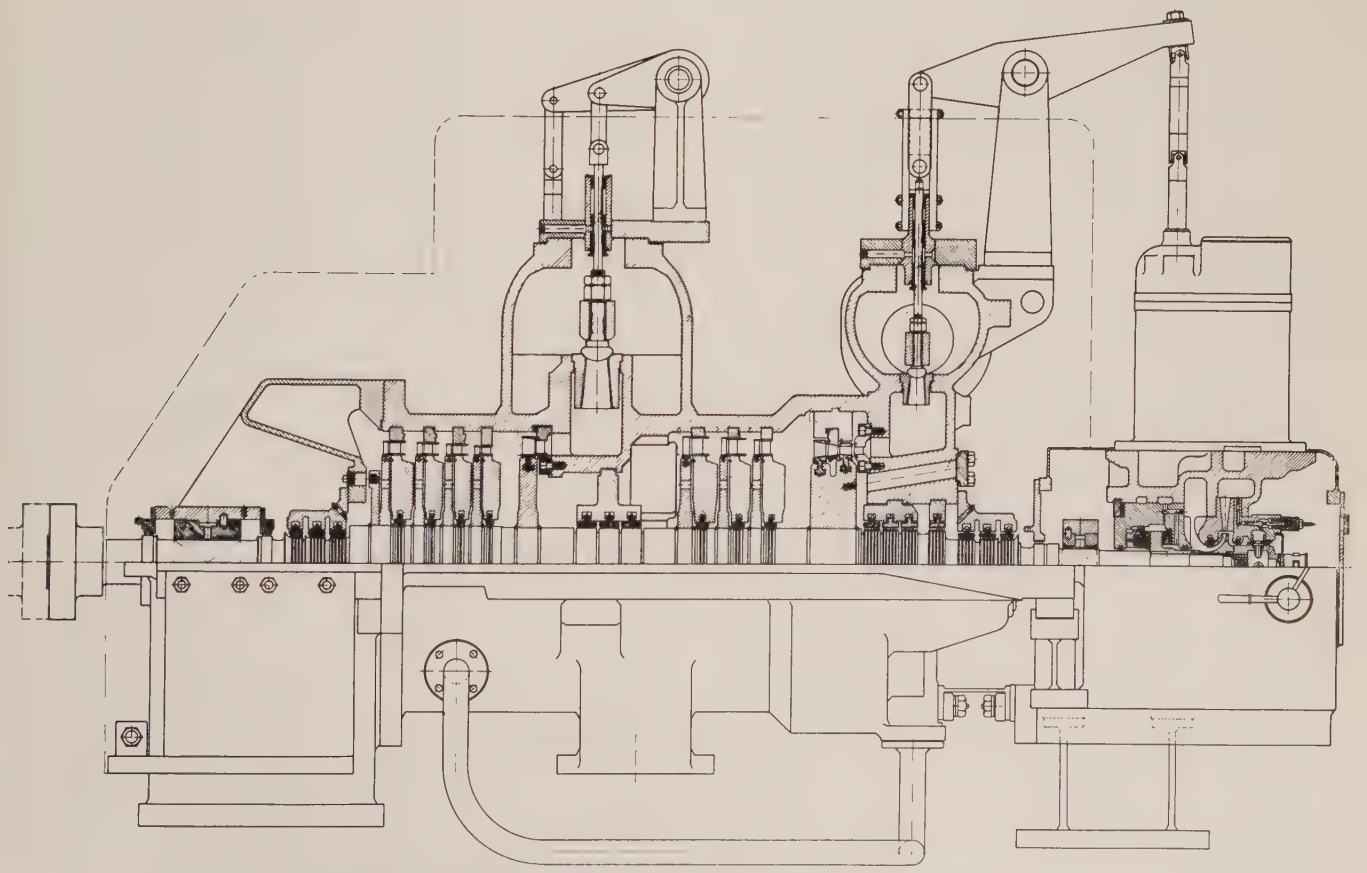

Fig. 5. 4000-kw. noncondensing single extraction turbine

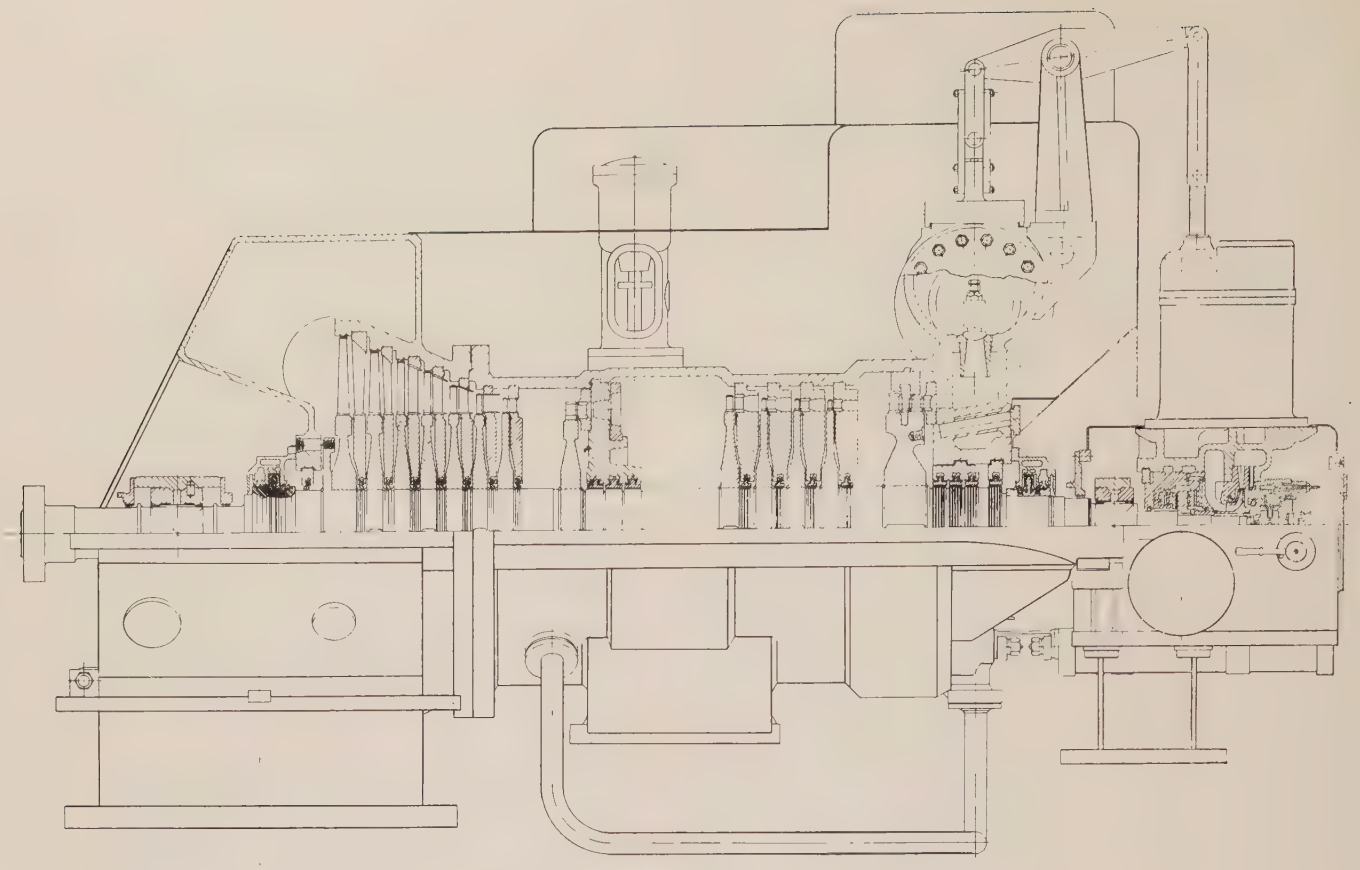

Fig. 6. 6000-kw. condensing single extraction turbine

at 25 p.s.i. The 6000-kw. units operate on 325 p.s.i., 625°F. inlet steam conditions extracting at 25 p.s.i. and exhausting at 28 inches mercury absolute pressure. Steam demands and electrical demands for the entire year were developed and five typical conditions of loading selected for detailed study: (1) six Winter months, 1944–45; (2) high day, March 1, 1946; (3) month of March, 1946; (4) high operation existing plant; and (5) high operation with new paper machine.

To arrive at the final selection these five load conditions were studied for various combinations of condensing single and double automatic extraction units in combination with the noncondensing single automatic extraction turbine. It will be noted that a new 600-pound boiler is included in the plant expansion. Before arriving at the final selection, consideration was given to the possibility of using the 600-pound steam on the condensing unit. Figure 4 is the diagram of the final arrangement showing the process steam requirements, the total steam generated and the byproduct power produced for the five load conditions. Figure 5 shows the section through the 4000 noncondensing unit and Fig. 6 shows the 6000-kw. unit.

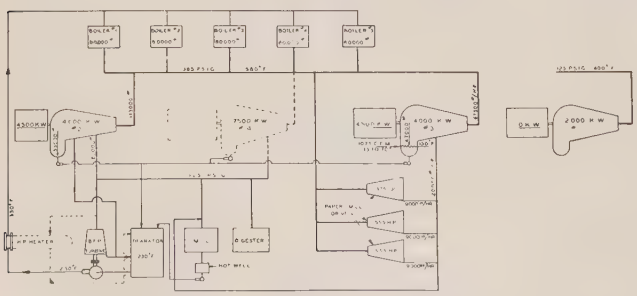

Fig. 7. Power plant arrangement for Rhinelander Paper Co.

REGENERATIVE FEED WATER HEATING

While the turbine generator ratings for most paper mill units fall within the range of 500 to 7500 kw. the steam requirements for these units, however, are in many cases equivalent to that required for many central station installations. Practically every large steam turbine installation operates with regenerative feed-water heating. The paper mill engineer should be conscious of the economy resulting from such operation. The Rhinelander Paper Co., Rhinelander, Wis., has recently placed in service the high-pressure heater shown in the power plant arrangement in Fig. 7. The Rhinelander plant utilizes something over 200,000 pounds of steam per hour which compares with the flows required for a conventional 20,000-kw. straight condensing unit. Such a condensing unit would in all probability be provided with at least three stages of feedwater heating.

Based on operating steam conditions of 400 p.s.i., 750° total temperature, and $1^1/_2$ inches of mercury absolute back pressure, the improvement in heat consumption for a straight condensing turbine can be obtained from Fig. 8. For other types of units such as automatic extraction the savings will generally differ from those on the curve and the actual savings must be calculated. The plant at Rhinelander closely approximates conditions in Fig. 8. The steam temperature has only a small influence on the gains obtained by stage heating. For comparison with Fig. 8 assume that the original plant layout including the deaereator is equivalent to the two-stage feed heating system. The

230°F. condensate from the deaereator approximates the temperature from the second heater on the normal 20,000 kw. straight condensing unit. Referring to Fig. 8 the reduction in heat consumption with a final feed temperature of 230°F. over no feed heating whatsoever is 6.7%. The installation of the high-pressure heater giving a final feed temperature of 330°F. results in a potential gain of approximately 2%. Actually the original feedwater heating system having only the deaereator at Rhinelander falls between the one and two-stage systems on Fig. 8. The two-stage system was chosen to show a conservative gain by the high-pressure heater. It will be noted from curve 8 that the final feed temperature of 330°F. giving a total temperature rise in the feedwater of 238°F. results in a maximum reduction in heat consumption for a three-stage system.

Figure 8 shows that for all practical purposes the maximum reduction in heat consumption for three-stage heating is obtained for total rise in feedwater temperatures from 220 up to 270°F. The high-pressure extraction in the paper mill usually falls in the pressure range of 125 to 175 p.s.i. The final feed temperature therefore results in a rise between 220 and 270°F. giving an ideal situation for feedwater heating.

This paper is limited to the industrial turbine generator drives. In making the plant studies, however, the general purpose mechanical drive turbines which have hundreds of applications in industry must be included in the over-all heat balance for the most economical plant operation. K. S. Kramer's paper (*1*) on steam turbines for paper mills illustrates the wide application for the mechanical drive turbines.

CONTROL SYSTEMS

To obtain full value from the turbine installation the unit must have a control system which will function to supply the process steam and load requirement and at the same time give dependable trouble-free operation. Realizing the importance of these requirements, Westinghouse pioneered and developed for industrial turbine users the complete hydraulic lubricating and control system with the main pump mounted directly on the shaft with a priming ejector in the oil reservoir.

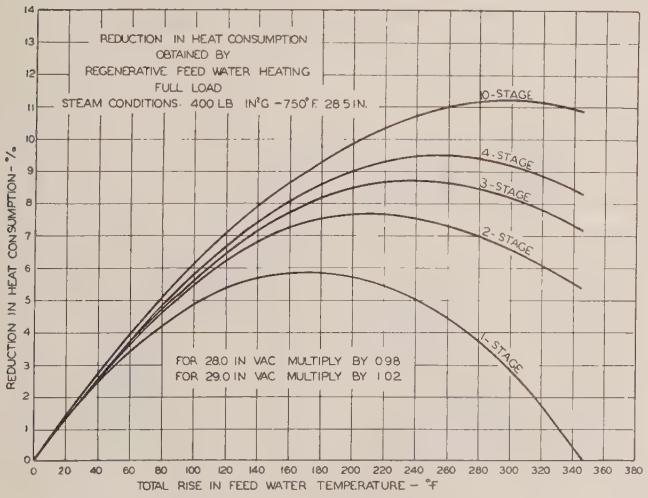
REDUCTION IN HEAT CONSUMPTION OBTAINED BY REGENERATIVE FEED WATER HEATING FULL LOAD
STEAM CONDITIONS- 400 LB IN²G - 750°F 28.5 IN.
10-STAGE
4-STAGE
3-STAGE
2-STAGE
1-STAGE
FOR 28.0 IN VAC MULTIPLY BY 0.98
FOR 29.0 IN VAC MULTIPLY BY 1.02
REDUCTION IN HEAT CONSUMPTION - %
TOTAL RISE IN FEED WATER TEMPERATURE - °F
0 20 40 60 80 100 120 140 160 180 200 220 240 260 280 300 320 340 360 380
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14

Fig. 8. Reduction in heat consumption obtained by regenerative feedwater heating

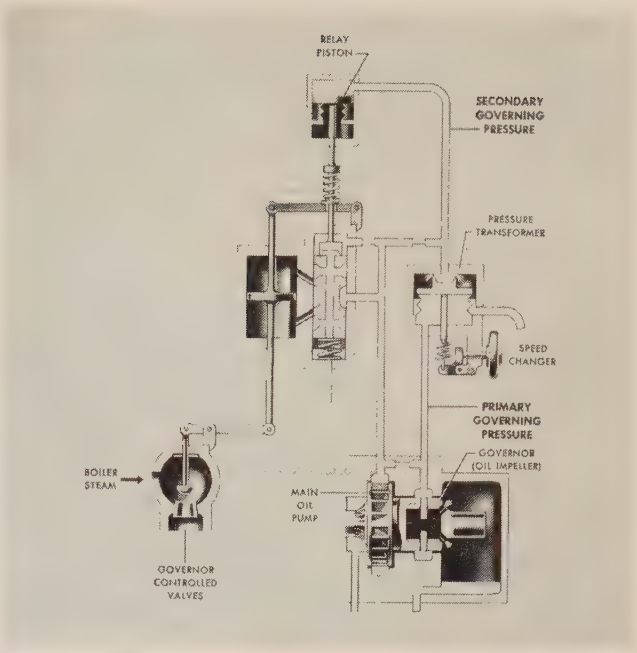

Fig. 9. Hydraulic governing system speed control

This lubricating and control system with its inherent flexibility and low maintenance proved to be so successful on the industrial turbines that it was also adopted as the standard system for all Westinghouse central station units.

Figure 9 shows the hydraulic governing system speed control elements of the turbine. The governing system speed control consists of (1) the main pump mounted directly on the turbine shaft. The purpose of the main pump is to furnish the operating and motive oil for the entire system. (2) The governor (oil impeller) is mounted on the shaft adjacent to the main pump and receives its motive oil from the main pump through an orifice. The flow of oil in the governor oil impeller is from the outside diameter inward toward the drain cavity as illustrated in Fig. 9. There are actually eight radial holes in the governor oil impeller resulting in eight columns of oil which due to centrifugal force resist the flow of oil inward through the impeller. Changes in speed effect the resistance to inward flow causing the primary governing pressure to vary as the square of the speed giving a positive governing medium. (3) The initial governing force amplifier magnifies the primary governing pressure changes. The initial governing force amplifier consists of a cup valve attached to a bellows and referring to Fig. 9, it will be noted that in order to have the condition of equilibrium the combination of the secondary governing pressure acting on the cup valve plus the speed changer spring load must balance the primary governing pressure acting on the bellows area. The pressure magnification therefore depends on the ratio of the bellows area to the cup valve area which is generally five to one thus obtaining a governing pressure to actuate the relay piston which is extremely sensitive to speed changes.

The governor servo-motor consists of the relay piston, the relay, the operating piston, and the follow-up spring. The unique feature of the servo-motor is the power-operated relay which eliminates any mechani-

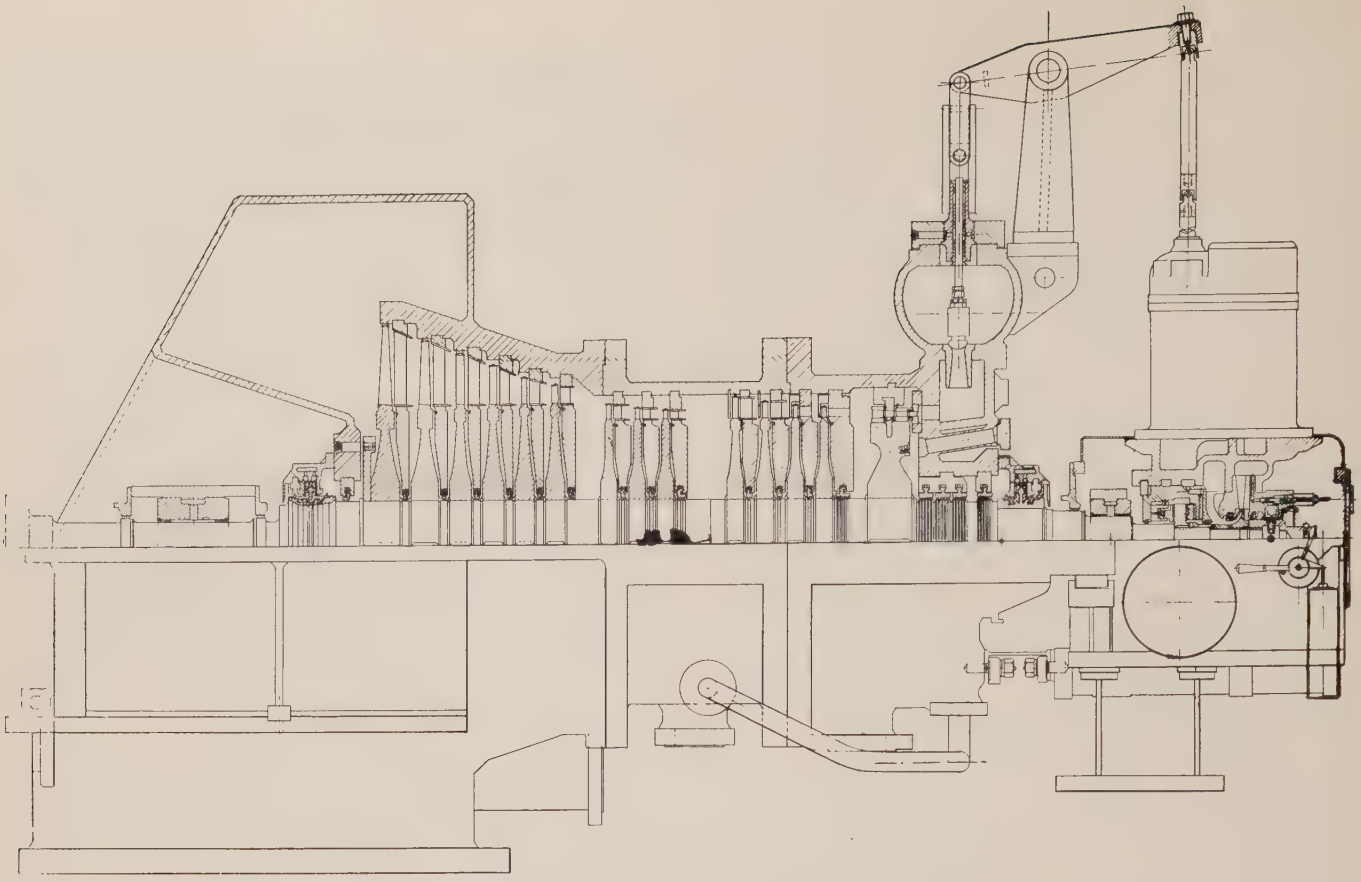

Fig. 10. 5000-kw. straight condensing turbine

cal connection between the relay piston and the servo-motor relay. The relay piston merely positions the cup valve above the relay and the oil pressure in this chamber supplied directly from the main pump positions the relay to admit oil to the operating piston cylinder.

To illustrate the functioning of the hydraulic governing system speed control assume a speed increase due to a drop in load, unit operating isolated. The speed governing impulse starts with an increase in the primary governing pressure which is magnified by the initial governing force amplifier. The increased secondary governing pressure acting on the relay piston, positions the relay cup valve closer to its seat causing the pressure in this chamber to increase and should the necessity arise there is full pump pressure available to move the relay. With a downward movement of the relay high-pressure oil is admitted below the operating piston. The operating piston will move upward, closing the governor control valves until the follow-up spring load balances the secondary governing pressure. The spring under the relay returns it to its neutral position. In the case of increasing load, the reverse action of the control system is obtained, resulting in opening of the governor control valve. This same load change is made by setting the speed changer when the turbine generator is operating in parallel with other units.

Figure 10 shows a typical straight condensing unit which utilizes the control system as shown in Fig. 9.

Figure 11 shows the exhaust pressure-control system. You will find this system to be the same as on Fig. 9, with the addition of the exhaust pressure regulator and its hydraulic links to the governor servo-motor. Both the speed responsive element and the pressure responsive element are connected into the same chamber of the governor servo-motor. The governor servo-motor is arranged so that a falling pressure in the relay piston chamber opens the steam inlet valve. Therefore, by the addition of a ball check valve in each of the hydraulic links to the relay piston chamber, there is

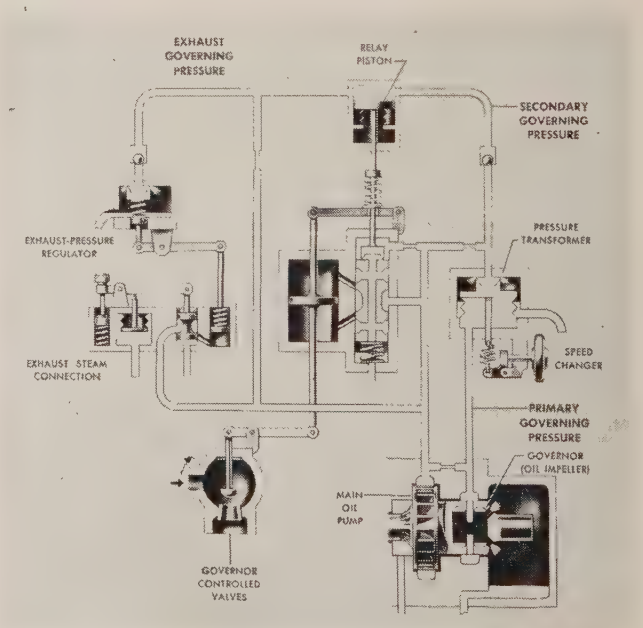

Fig. 11. Exhaust pressure control

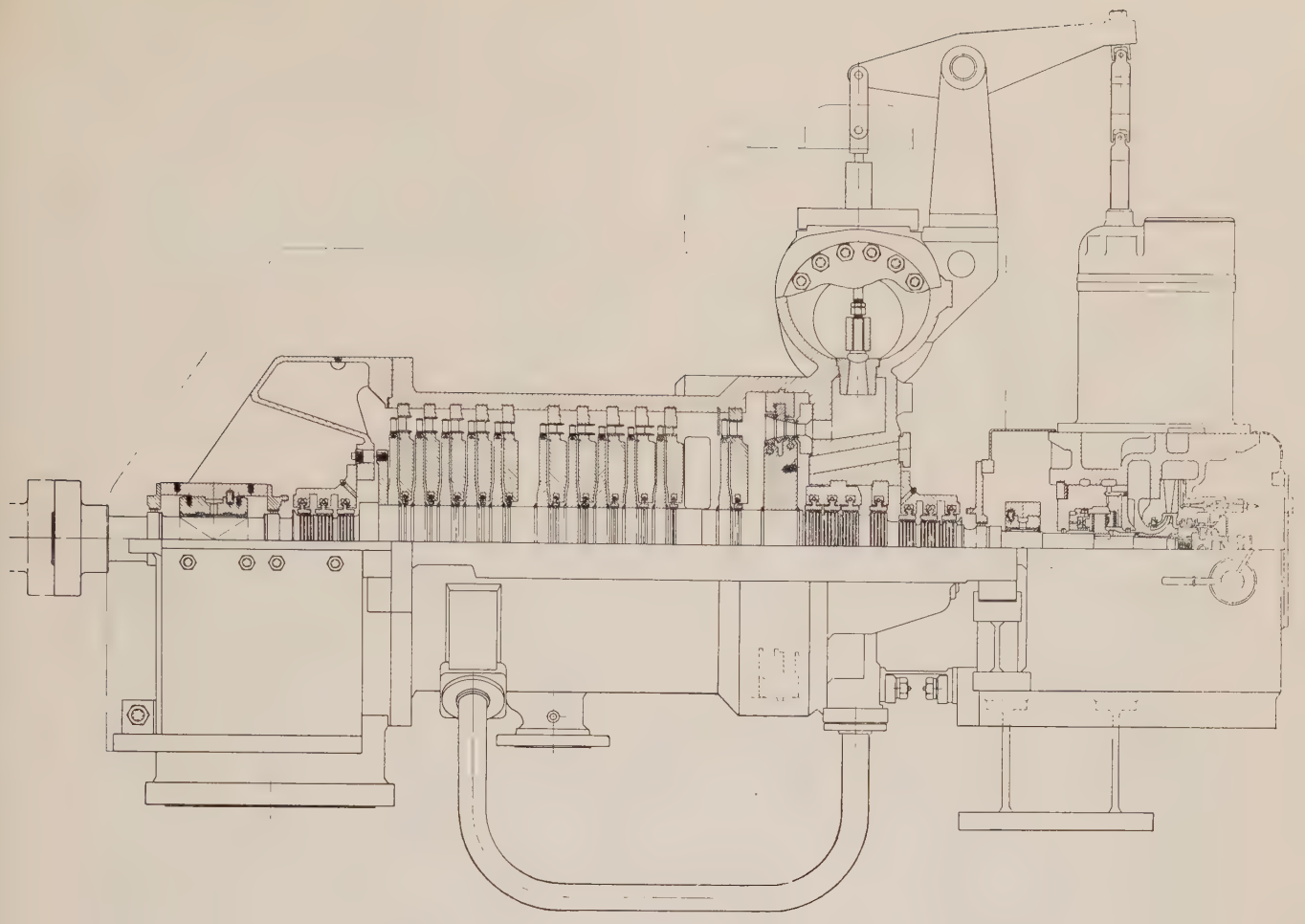

Fig. 12. 4000-kw. noncondensing turbine

an arrangement which permits the cup valve maintaining the higher pressure to take over the control of the steam inlet valves. To obtain full valve travel under control of the exhaust pressure regulator, the speed changer must be set in its maximum load position blocking the secondary governing pressure at its lowest value. With the exhaust pressure regulator cut out of service, the speed-control system is identical to Fig. 9.

The 4000-kw. turbine for the Container Corporation of America, Chicago, Ill., Fig. 12, designed for steam conditions of 400 p.s.i., 750°F. total temperature, 45 p.s.i. exhaust pressure it typical of the type unit employing the exhaust pressure control.

The single automatic extraction control system is shown in Fig. 13. In this system a double cup regulator plus an extraction valve servo-motor has been added to the control system shown in Fig. 9, and the relay piston cylinder is divided into two chambers. The purpose of this system is to control automatically the speed or load and the extraction steam pressure at the same time, without a change in either of the variables affecting the other as long as the unit is operating within its design limits. Speed responsive secondary governing pressure is piped to both the main governor and extraction valve servo-motors. Any change in this pressure will move the two servo-motors together in the case of an increased load demand, to open both the high pressure and extraction steam flow control valves to pass the additional steam flow to the turbine exhaust. In the case of a decrease in load both servo-motors are moved to close their respective valves reducing by the same amount the steam flow to the high-pressure and low-pressure sections of the turbine. Thus, the load change is effected without a change in the flow to the extraction line or in upsetting of the extraction pressure.

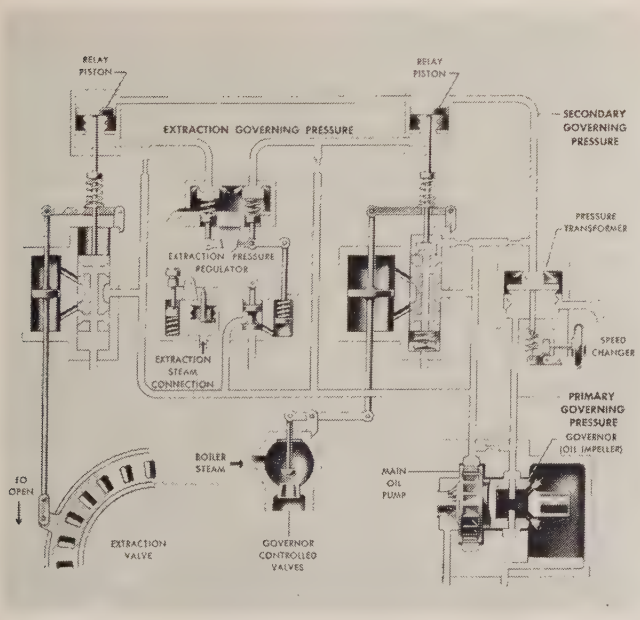

Fig. 13. Single automatic extraction control

The extraction pressure regulator functions to maintain a substantially constant extraction steam pressure. The control system should permit this requirement without interference to the load demand. An increase in extraction demand will cause the extraction pressure to drop. This drop in pressure will allow the extraction regulator relay to move in a downward direction admitting high-pressure oil under the piston, causing it to move in an upward direction. The cup valve controlling the extraction governing pressure to the main governor servo-motor moves closer to its seat increasing the pressure under the relay piston. Increasing the pressure moves the governor relay upward admitting high-pressure oil above the operating piston opening the steam inlet valves increasing the steam flow to the extraction line to restore the extraction pressure.

to pass additional steam to the turbine exhaust to develop an equivalent electrical load as that lost to byproduct power as a result of reduced steam flow through the high-pressure end of the turbine. Thus, process steam demands are automatically supplied without interference to the electrical load.

The extraction mechanism may be cut out of service if desired. The extraction valve will take the wide open position and the unit will operate under speed control identical to Fig. 9. The 6000-kw. unit for the P. H. Glatfelter Co., Fig. 6, is typical of the type unit using the single automatic extraction control where the extraction valve is of the sliding grid type. The 4000-kw. unit for the P. H. Glatfelter Co., Fig. 5, shows a single automatic extraction turbine with the second stage steam chest type extraction valve. How-

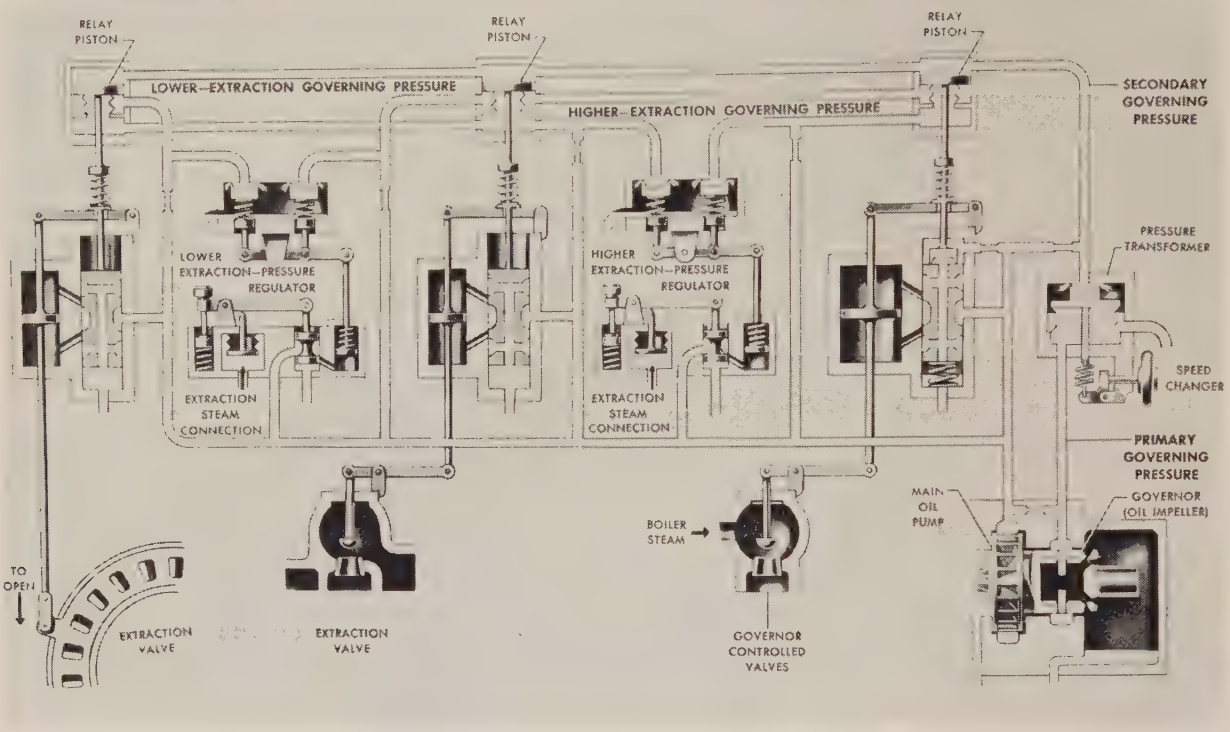

Fig. 14. Double automatic extraction control

Since there is an increase in process flow there is likewise an increase in byproduct power, however, the electrical load has not changed and an unstable operating condition exists. To overcome this condition, a second cup valve is added to the extraction pressure regulator which controls the extraction governing pressure to the extraction valve servo-motor. At the same time, the first cup valve is increasing the pressure under the main governor relay piston to increase the steam flow to the extraction chamber, the second cup valve is decreasing the pressure under the extraction servo-motor relay piston to close the extraction valve and reduce the flow to the turbine exhaust. The regulator cup valve springs are chosen so that for an increase flow to the high-pressure end of the turbine there is a proportional flow decrease through the exhaust end to maintain the same electrical load. If the extraction pressure should rise, the reverse operation of the control system is obtained, shutting off the flow to the main governor valve and opening the extraction valve

ever, in this case, the control system consists of a combination of the exhaust pressure control, Fig. 11, and the single automatic extraction control Fig. 12 controlling both exhaust and extraction pressure.

Double automatic extraction control is shown in Fig. 14. In this case a two cup extraction pressure regulator, extraction servo-motor and an extraction valve have been added to Fig. 13. Therefore, the control system must function to maintain speed or load plus the two extraction pressures automatically without a change of any one of the three variables effecting the other two within the design limits of the unit. The relay piston cylinder at each servo-motor is divided into three chambers to permit the pressure impulses resulting from speed changes and extraction pressure changes to act on each of the three servo-motors. Speed responsive secondary governing pressure is piped to each servo-motor relay piston. This means that all three servo-motors will move together and in the same direction in response to speed changer

setting or speed changes. Likewise, each extraction pressure regulator control pressure is piped to all three servo-motors causing them to move in the correct direction in response to extraction pressure changes.

Assume there is a pressure drop in the high-pressure extraction line. This means additional steam is required to process. The action of the high-pressure extraction regulator will be identical to that on the single extraction unit described previously increasing the control oil pressure to the main governor servo-motor which results in additional steam flow to the high-pressure section of the turbine. This of course, results in additional byproduct power generated by the high-pressure section, and it is necessary to reduce the output of the intermediate and low pressure sections by the same amount in order to have stable operation.

Ark., and Bastrop, La., (operating on steam conditions of 400 p.s.i. – 700° FTT $27^1/_2$ inches mercury absolute exhaust pressure extracting at 175 and 75 p.s.i. shown in Fig. 15) are typical of the double automatic extraction units employing the control system shown in Fig. 14.

LUBRICATION AND OVERSPEED SYSTEM

The lubricating system and overspeed protection is the same independent of type of turbine whether it is straight condensing or a double automatic extraction. Figure 16 illustrates the lubrication and overspeed system added to the speed control, Fig. 9, completing the control and lubricating system for a straight condensing unit. Lubricating oil under pressure is supplied to all journal and thrust bearing from the main pump

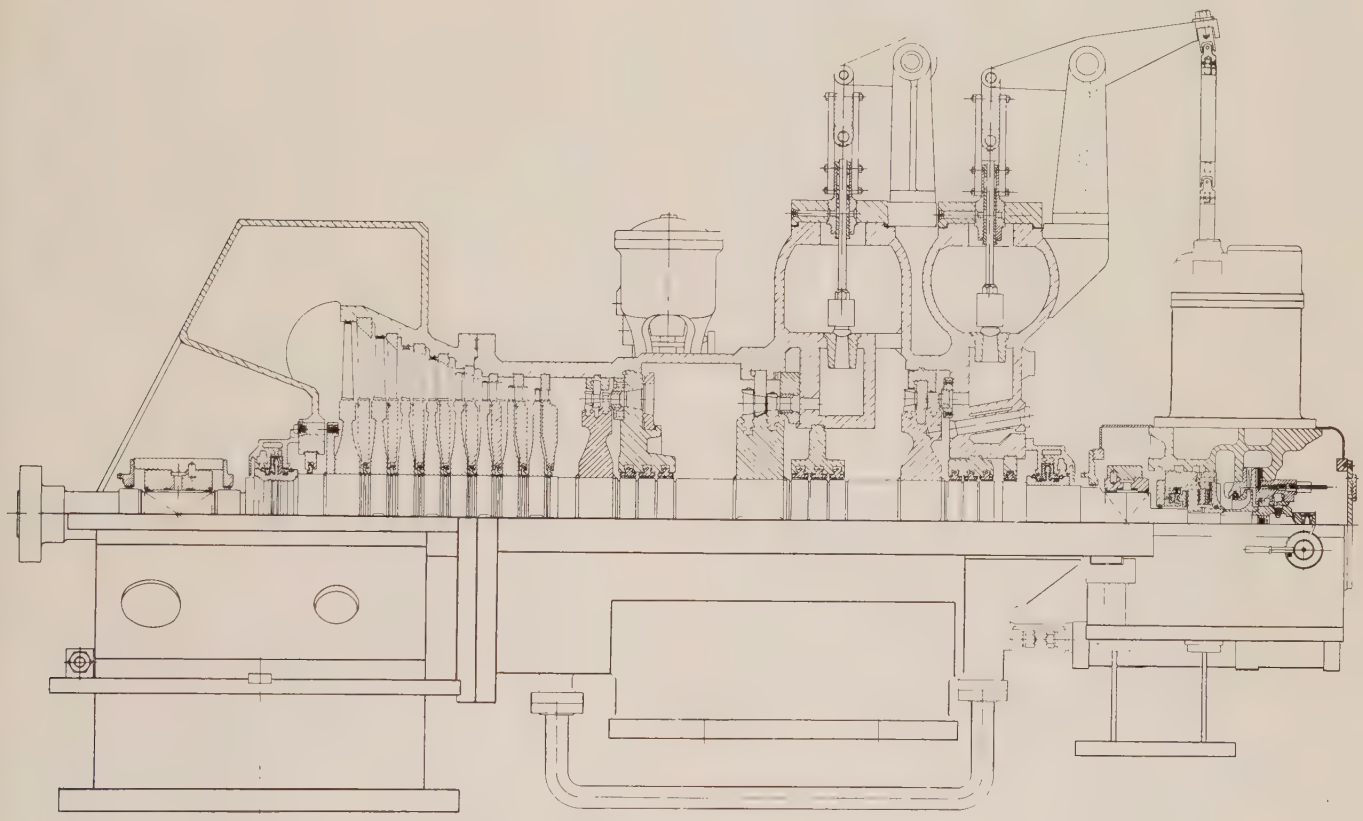

Fig. 15. 6000-kw. double automatic extraction turbine

This requirement is accomplished in the same manner as on the single extraction unit except that the control oil from the second cup in the regulator is piped to both extraction servo-motors, and will cause both extraction valves to move in the closing direction to reduce the flow to the intermediate and exhaust end by the proper amount. A decrease in high-pressure extraction requirement will result in a closing of the main governor valve and the opening of the two extraction valves.

The low-pressure extraction regulator will open both the main governor and high-pressure extraction control valves and close the low-pressure extraction valve to satisfy additional low-pressure extraction requirement. The reverse action will be obtained on decreased low-pressure extraction flow demands. The 6000-kw. unit for the International Paper Co., Camden,

discharge. An orifice ahead of the oil cooler reduces the lubricating oil pressure to 10 p.s.i. at the bearings. The main oil pump is not self-priming and its suction oil is supplied by an ejector located in the oil reservoir. A portion of the high-pressure oil from the main pump discharge is utilized for the operating medium in the ejector. The throttle and trip valve is hydraulically operated receiving oil from the main pump through an orifice. Loss of oil pressure under the trip valve piston resulting from tripping of the overspeed trip automatically closes the throttle and trip valve. If the necessity arises the overspeed trip may be operated manually. An auxiliary oil pump and regulator are furnished for starting and shutting down the unit. The oil pump regulator is controlled by the bearing oil pressure and a drop in this pressure to a predetermined value will automatically start the auxil-

iary oil pump. In starting, the auxiliary oil pump furnishes lubricating oil, main pump suction, and motive oil for opening the throttle and trip valve. While the trip valve can be manually closed, it cannot be opened unless motive oil is available under the piston. This motive oil cannot be made available unless the overspeed trip is latched.

An examination of the control charts shows that both speed and pressure control depend simply on pressure impulses carried by the hydraulic links to the various mechanisms in the control system. The addition of a control mechanism is readily accomplished by providing the necessary hydraulic links, which require no fixed configuration, to connect it into the system. There are no wearing parts in the hydraulic links. Variations in extraction steam flow or electrical load automatically take place without either variable af-

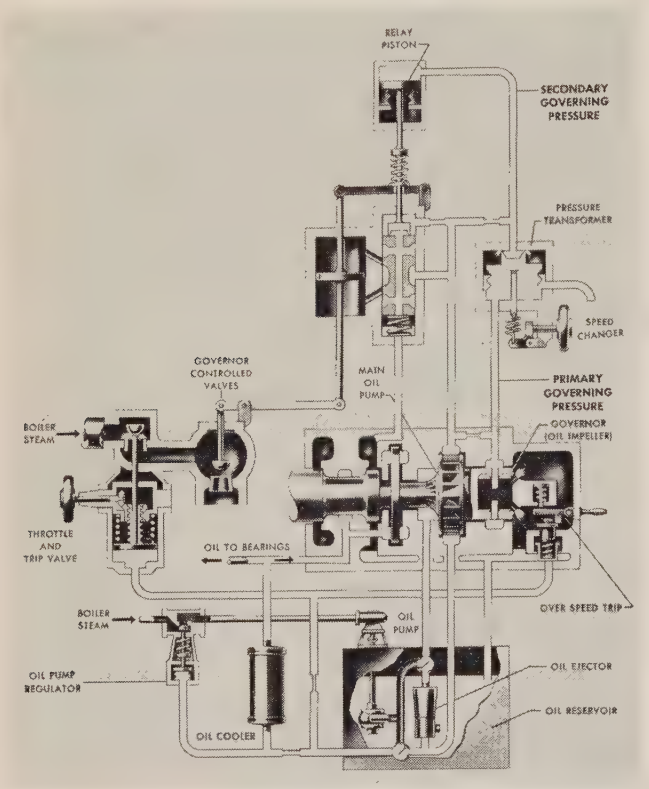

Fig. 16. Lubrication and control system

fecting the other. Positive pressure lubrication is provided during operation with an auxiliary pump, automatically controlled by the bearing oil pressure, furnishing lubricating and motive oil for starting and stopping. Thus, trouble-free dependable operation is assured.

STANDARDIZATION

The industrial turbine user should give consideration to the standardization of industrial turbines for future application. A review of the industrial turbines sold by Westinghouse during the years of 1944 to 1947 inclusive reveals that there were 169 different combinations of inlet steam pressure and temperature and a like number of combinations of exhaust and extraction pressures. It is obvious that with such a large diversity of conditions confronting the manufacturer, a large portion of his time and talent is utilized in recombining individual parts into tailor-made equipment which if freed by standardization could be used to better advantage to develop and improve the product.

Since August, 1945, when the first standardized central station unit was sold, Westinghouse alone has sold approximately 75 standardized units having a total capacity in excess of 3,000,000 kw. The central station industry today is reaping the benefits of standardization in the form of reduced cost and improved equipment. It is realized that the end product of the central station industry is the generation of electrical power, whereas, the industrial turbine in many cases is looked upon as a necessary evil involved in the plant production. Nevertheless, any improvement in either cost or performance of the turbine equipment should be of vital interest to the industrial user.

The line of standardized central station turbines is the result of the combined efforts of the turbine users, the consulting engineers, and the manufacturers. The widespread acceptance of the standardized units by the central station industry is evidence that there are worth-while advantages offered by these units. With the same type of cooperation between the industrial turbine users, the consulting engineers and the manufacturers of industrial turbine equipment a line of standardized industrial turbines can be established making available similar advantages in turbine equipment to the industrial users. It would appear that the paper industry working through TAPPI is in an excellent position to participate in a standardization program. In this connection Westinghouse will appreciate the opportunity to do its part in formulating the standardized industrial turbines.

As fuel costs increase it is more important than ever to select the right turbine for the job. This can be done if the turbine is selected on the basis of a thorough knowledge of the plant requirements. Plant analysis similar to that illustrated is of utmost importance in obtaining a successful turbine installation. Further savings in fuel costs are made possible by the application of feedwater heating cycles.

Satisfactory operation on a modern industrial turbine depends almost entirely on the control system. The control system illustrated clearly shows that practically any type of operating requirements can be satisfied automatically by the turbine. The opportunities for reduced plant costs resulting from standardization should be given full consideration. In this connection technical associations such as TAPPI with the assistance of consulting engineers and the manufacturers should take the lead in establishing the standards.

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1949 TAPPI Fall Meeting

Over 700 registered for the Fall Meeting of the Technical Association of the Pulp and Paper Industry which was held Sept. 12–15, 1949 at the Multnomah Hotel in Portland, Ore. This was TAPPI's third meeting on the Pacific Coast, the first having been held at Portland in 1934 and the second in Seattle in 1940.

On Monday, a group visited the Weyerhaeuser logging operations at Camp Baker near Spirit Lake. Howard W. Morgan, manager of the Weyerhaeuser pulp division, was general host to TAPPI, and introduced Harry Morgan, manager of the lumber division of the company under whose direction arrangements for the woods tour was made.

The purpose of the tour was explained to acquaint the visitors with Weyerhaeuser forest practices and policies and to give them a graphic idea of the harvest methods used to procure raw materials for the pulp and paper industry.

Detailed arrangements for the trip were made by Clyde Corman, woods superintendent, and his staff, including Glenn Masterson, logging superintendent; Art Blaine, assistant logging superintendent; Ivan Slater, Camp Baker Foreman.

Ed Heacox, chief forester for the entire Weyerhaeuser Timber Co., gave a general explanation of company policies and the firm's forest program.

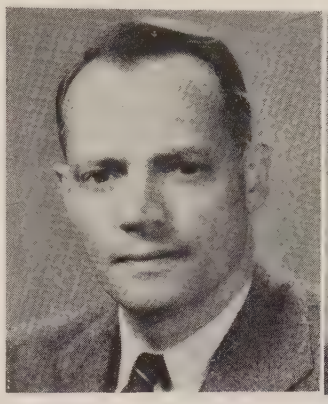
A demonstration of load transfers—where logs are removed from trucks and loaded on railroad cars—was given.

The visitors were treated royally—bulldozers had carved out a natural grandstand on a mountain slope so they could see in stretching panorama the high lead logging and arch cat skidding methods. The spot selected for the demonstrations was at the end of one of the logging roads where those operations were normally being carried on side by side—as the terrain warranted.

In addition, a falling and bucking demonstration was given by Elias Swift and Herman Kwandt, both of whom soon will be Weyerhaeuser 20-year men.

High climbers included Harold Johnson, now a company employee, who recently won the world's championship high climbing events at Albany, Ore.; and Paul Preston, climbing for Weyerhaeuser since 1943.

A fir being cut by chain saw into logs 40 to 48 feet long



A. G. Natwick ***R. J. LeRoux***

General Co-chairmen

Guides for the trip included Nelson Jeffers, chief forester for the Longview branch; Jake Hisey and Jack Larson, foresters; Harold Haskins, auditor for the logging operations; Russell Carmichael, assistant road master; Jack Johnson, veteran employee and camp foreman; William Fullenwider, safety department inspector; Harold Brayne, purchasing agent; and Everett Barton. Albert Arnst, Tacoma, was the company photographer on the trip.

Tuesday was devoted to mill visits arranged with the cooperation of the Longview Fibre Co., the Weyerhaeuser Timber Co., the Crown Zellerbach Corp., and the Publishers Paper Co., to the plants at Longview, and Camas, Wash. and Oregon City and West Linn, Ore.

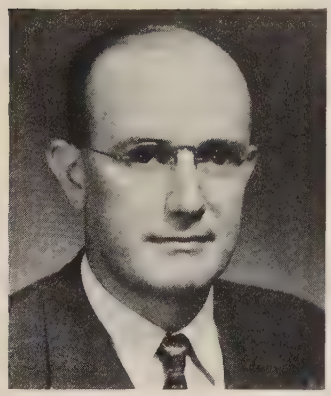
Opening Session

On the morning of September 14, the technical program was opened by W. F. Holzer of the Crown Zellerbach Corp., Chairman of the Program Committee, who after welcoming the group, introduced H. K. Benson of the University of Washington, one of the organizers of the Pacific Section of the association. Mr. Benson spoke as follows:

"At this opening session of the 1949 Fall Meeting of National TAPPI, it is a pleasure for the Pacific Section to extend its greetings of welcome to all who are in attendance. The Pacific Section has now reached its 21st year of manhood and accordingly feels qualified to speak for itself modestly but firmly, and one of these prerogatives is a word of welcome to the officers and membership of the parent organization. We owe much to you for the inspiration and encouragement given to us and to the industry we represent. For this we are grateful and make acknowledgement.

"When I first came to the University of Washington from my graduate work in Johns Hopkins and Columbia Universities in 1908, I was told to forget my dreams of research in my major field of physical chemistry and turn toward the development of a course in industrial chemistry which might give point to the curriculum of chemical engineering which had previously been established as a composite of chemistry, physics, mathematics, and engineering courses. The first thing I did was to visit as many of the industries of the Pacific Northwest as possible. One of the first was a very pleasant visit to the pulp and paper mills at Camas and West Linn. At the latter, I found W. M. Hedden, F. A. Olmsted, and Vance Edwardes. The trip through the mill was of great interest to me, as was also a very fine

lunch at the home of Mr. and Mrs. Edwardes. When an executive in the Portland office asked me to stop in at his office before leaving Portland to tell him of my visit, I told him that the mills, in my opinion, were splendidly organized and operating efficiently and that it was an industry that might be greatly extended. He said, "Oh, no, don't ever say that. We have difficulty to sell all that we make now." Nevertheless, these mills continued to grow in size and output and today are among the leaders in the nation's production of fine paper products. Not only did the existing mills increase their capacities, but many new mills were constructed, so that in the five-year period 1923 to 1928 the daily production of pulp in the states and provinces bordering on the Pacific Ocean doubled. Nevertheless, this rapid growth caused some surprise and wonderment in the industry elsewhere. One incident may be related to illustrate this feeling.



W. F. Holzer
Chairman, program committee

"When the late Harrison E. Howe, Editor of Industrial and Engineering Chemistry, came to Seattle in 1928, he expressed much concern about the mill at Shelton which had just begun operation. He asked, "How can a mill built in the wilderness, 3000 miles from its customers in New York and New England, hope to succeed?" He asked me to prepare an article for the journal in answer to his query and offered to pay for the article. I accepted the assignment and propounded the question to David B. Davies, manager of the Shelton mill, who answered it simply and concisely. "In the mill I just left," he said, "the nearest spruce was a 100 miles and the nearest hemlock 600 miles from the mill. Here at Shelton the farmers and woodsmen bring the pulpwood to the mill at a cost of a fourth of what I paid in the other mill. The fuel costs are 15 cents per 1000 pounds of steam, while the cost in Wisconsin was from 38 to 48 cents. The freight cost of pulp by rail from the Midwest to the Atlantic Coast is more than the cost by boat from the Pacific Coast." This answer satisfied Mr. Howe's curiosity. He published the article in the August, 1930 number of the journal and sent me a check for $25.00.

"With this background of happenings on the Pacific Coast, it can be understood why Bill Breitenback and your speaker found such a ready eagerness among those in responsible charge of the industry to accept an invitation from the University to assemble in a conference October, 1928, to discuss the formation of a section of the Technical Association on the Pacific Coast.

"In its early stages, the new section had the customary struggle for existence but it had the support of such well-known leaders as Dick Cash, Bob Wertheimer, and C. W. Morden, chairmen during the first three years. At National Headquarters it had the consistent support of Secretary R. G. Macdonald, B. T. McBain of the Executive Committee, and President P. H. Glatfelter. Harlan Scott, Editor of Pacific Pulp and Paper Magazine and Larry Smith were traveling evangelists exhorting the membership to be faithful and loyal. The base of Pacific TAPPI was greatly broadened by the skillful activities of Lawrence Killam of British Columbia, during whose chairmanship, National TAPPI came to the Coast for the first time. It too, met in Portland.

"In the more recent years Bill Barber and Ray Hatch activated the section with magnificent success in holding a series of seminars in which in effect our membership comes back for some graduate work. In 1946, Dr. Heuser conducted the seminar on cellulose, in 1947, Dr. Mark discussed the physical chemistry of cellulose and in 1948, the Erdtmans dealt with the chemistry of lignin and extractives. These seminars were held at approximate cost of $1000 each and attended by 60 to 80 persons, part of whom were subscribers from industry and others from the colleges and universities were guests. Active plans are under way for the continuance of these seminars in 1950.

"We trust National TAPPI is pleased with its eldest offspring now fully grown and looking with eagerness into a busy future."

Mr. Holzer then introduced A. E. Bachmann, Missisquoi Corp., President of the Technical Association. Mr. Bachmann's remarks are given on the President's Page of this issue of *Tappi*.

R. G. Macdonald, Secretary-Treasurer of TAPPI, followed Mr. Bachmann and related briefly the organization of the Pacific Section which was the first of the association's local sections. Through the development of outstanding programs, the creation of the Shibley Award, excellent leadership, and strong support given by its members and the mill management of the area, this section has had a most important influence on the technology of the industry of the Northwest.

Because of its regional aspects, a section of the association becomes identified as TAPPI to those in the area, and since nearly everyone interested in pulp and paper may become members of one of these groups, its membership is composed of all segments of the pulp and paper and supply and service industries. The degree of success of each local organization tends to reflect upon the activities of the national association. It should be remembered that the same problems that confront the local groups are met by the national association, which can, however, call upon its members from any geographical area for assistance in developing and improving its divisional and committee activities. The publications of TAPPI, such as its magazine *Tappi*, the TAPPI Standards and Data Sheets, and the Bibliographies of Paper Making, reflect the extent of its activities and its emphasis on quality. It is hoped that the national committee organization pattern will gradually be noted by the leaders of the local sections as there is so much to be done and to be done well. The association is constantly endeavoring to attain the standards of a pro-

The start of falling a big hemlock tree with a power chain saw

(continued on page 40 A)

WHY POSTPONE UBTANTIAL DAILY $AVING$?

That's exactly what you're doing when you defer expenditure for needed stock recovery equipment until "business conditions improve."

The Bird Save-All is one item of equipment that should never be put in the "deferred" class — not so long as valuable fibres are being permitted to get away anywhere along the line. From the very instant it goes on the job, the Bird Save-All starts earning visible, tangible returns in the form of good fibres to be made into "pay" paper.

EVIDENCE

A board mill reports that the two Bird Save-Alls put in last year have already paid for themselves and every pound of stock they now save represents clear profit.

One papermaker writes, "The Bird Save-All in our mill represents a saving of $5000.00 annually." Another reports a return of 5500 pounds of fibre per month.

A mill that installed a Save-All with their pulp drying cylinder machine recovers a ton of stock per day, saves 600 gallons of fresh water a minute.

A specialty mill figures the net return from their first Bird Save-All at $168.00 per day and orders several more.

May we submit recommendations and estimates?

BIRD MACHINE CO.

SOUTH WALPOLE, MASS.

(continued from page 38 A)

Loading logs at a high-lead setting

The horizontal loading boom swivels on the spar tree at left. A high lead cable, also attached to the top of this spar tree, runs back into the logged area from where logs are dragged in to the loading landing.

fessional society and it would like to have its local sections strive in the same direction insofar as they are able to do so in meeting the needs of their members.

William R. Barber, Technical Director of the Crown Zellerbach Corp., spoke on the meaning of the Shibley Award which has now been presented thirteen times, to acquaint those who are not aware of it, the character of the man who had it as his ideal. Mr. Barber remarked as follows: "It could never be better said, that the good a man does lives after him. So with Kenneth Shibley. Whatever evils he might have done, if there were any, are forgotten and unknown. The good he did lives as an imperishable monument. There is a company of men, now some sixty in number, some of them still young, others now in their mid-ages of pulp and paper job responsibilities who have an honorable thing in common; they were all participants in the honorable effort to capture the Shibley Award. They should all of them have had first prizes in the competition for all put in that extra earnest thinking toward self-improvement which was the idea and ideal of the Award's founder.

"Kenneth Shibley was known to all his contemporaries as "Cap" Shibley. He was that kind of a man. A prominent Pacific Northwest chemical engineer for many years, a good business man operating his own company. His commercial connections were intimate with pulp and paper.

"Cap" was known throughout the continent as an authority on water treatment, and his work in designing and constructing water filtration plants on the Coast had contributed materially toward the cleanliness of Pacific Coast pulp and paper.

"He was active in the Technical Association of the Pulp and Paper Industry of which he was a member. He was also a member of the American Society of Civil Engineers, the American Waterworks Association, and of the Mount Baker Lodge, F. & A. M. of Mount Vernon, Wash.

"Mr. Shibley had lived in Seattle for ten years and was manager of the Shibley Company water treatment engineers.

"As an important part of his profession, Cap believed, and lived his belief, that it was a duty and a responsibility of the older men in industry to train the younger. He believed that continuity of succession was a first duty and obligation. He possessed a boundless faith in young men, an enthusiasm for them to succeed by doing upon their own initiative that small margin of extra thinking and work which marks the difference between the outstanding man and the mediocre man. In the nobility of his belief he established an annual award of $50 to the young man in Pacific Coast pulp and paper industry who would think out the preparation of a paper on some piece of his work and then suffer the torture of acquiring self-confidence by getting up on his feet before a crowd to tell others about it.

"Cap did not get to enjoy the fruits of his unselfish ideal. He died so shortly after, struck down in June, 1937 in his mid-years and his mid-career, to the deep sorrow of his host of friends. To further his belief in young men, the Pacific Coast Section of TAPPI reinstituted the Shibley Award competition in 1939. Each year since, four or five young fellows have had the get-up, the urge for self-improvement and the fun of competing for the Award, always considering the monetary part as secondary; that the true value of the competition lay in the training, the experience and the prestige in planning and executing the work; in preparing and presenting the paper values received not alone by the winner but by all.

"Year after year those who knew him in life become fewer. Nevertheless, those who follow will be refreshed in his faith and their responsibility in young men."

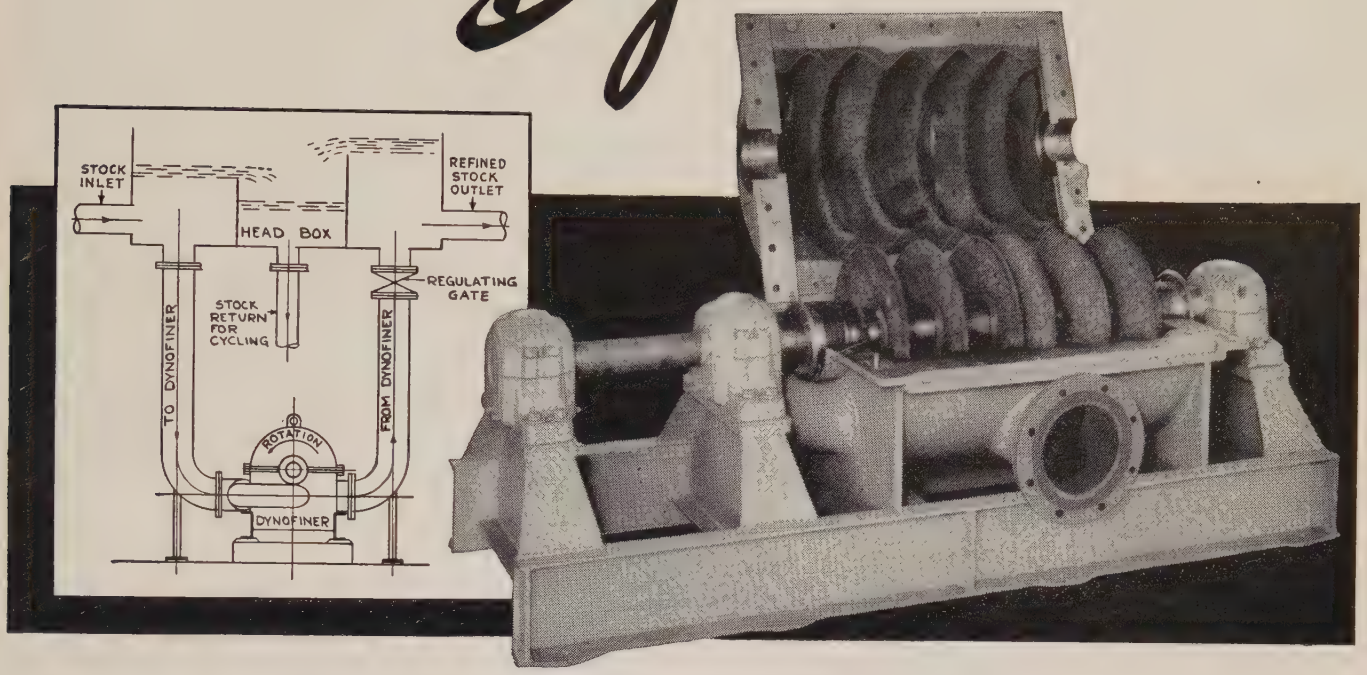
In discussing the status of the Pacific Coast pulp and paper industry, Lawson Turcotte, Vice-President of the Puget Sound Pulp and Timber Co., indicated that great strides have been made in a relatively short time toward perpetuation of the pulp and paper industry, fuller utilization of its raw materials, and further integration of operations, for which the members of TAPPI are to be thanked.

Probably the outstanding development on the Pacific Coast in the past few years is the expansion that has taken place in the field of raw materials for pulp and paper production. This is a combination of results in the technical and mechanical fields. The pulping of low-quality Douglas fir has made available a very substantial field of raw material. The addition of percentages of cedar has also developed additional supplies. Relogging of stands of all timber species is now an accepted practice. Although successful pulping of hardwoods will be more beneficial to other regions of the United States, these new developments will be available to West Coast mills if it is thought desirable and economically feasible to enter this field. The outstanding development on the mechanical side is the installation, or proposed installation, of hydraulic barking by practically every pulp plant on the Pacific Coast. This

Truck loads of logs arriving at a load-transfer station

(continued on page 42 A)

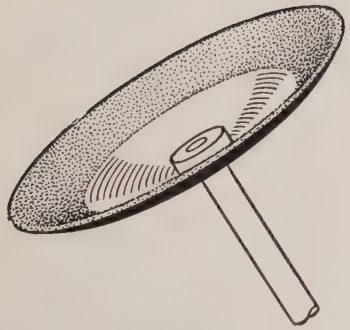
Here's the new DynoFiner



has no equal for continuous refining of paper stock

The efficient, continuous refining of pulp or waste paper is made possible with the DynoFiner through the use of a series of Dyno-Pellers. These are concave discs. The concave sides are lined with numerous pieces of tungsten carbide. Centrifugal force causes the pulp to be sucked and thrown against the tungsten carbide pieces. This effective dynamizing action continuously refines the stock, the fibres being completely separated one from the other.

If you want to make better pulp from a given grade of stock and make it cheaper, write today for further information on DynoFiners, for continuous operation—DynoPulpers, for batch operation.



The DynoPeller

is the heart of all DynoMachines. Notice how its concave face is studded with sharp particles of extreme hardness. These small points efficiently separate the fibres without hydrating, cutting or slowing down the stock.

RICE BARTON Research Corporation
WORCESTER 1, MASS.

(continued from page 40 A)

combination of technical and mechanical development has, by a conservative estimate, added 30% to the supply of raw materials. Add to this the intelligent reforestation programs put into effect by the pulp and paper industry, and there is assurance of a stable and perpetual industry which will grow in integration as the population increases in the Western States.

In the field of recovery of all utilizable materials from spent cooking liquor (which includes approximately 50% of the original tree as well as chemicals), the outstanding development on the Pacific Coast is the magnesium sulphite pulp recovery and power plant installation at Longview by the Weyerhaeuser Timber Co. Much research, time, effort, and money have gone into this one development which holds so much promise for complete integral utilization of the whole tree economically.

The economical manufacture of ethyl alcohol from waste sulphite liquor has been proved on the Pacific Coast, and other products from waste sulphite liquors are being marketed.

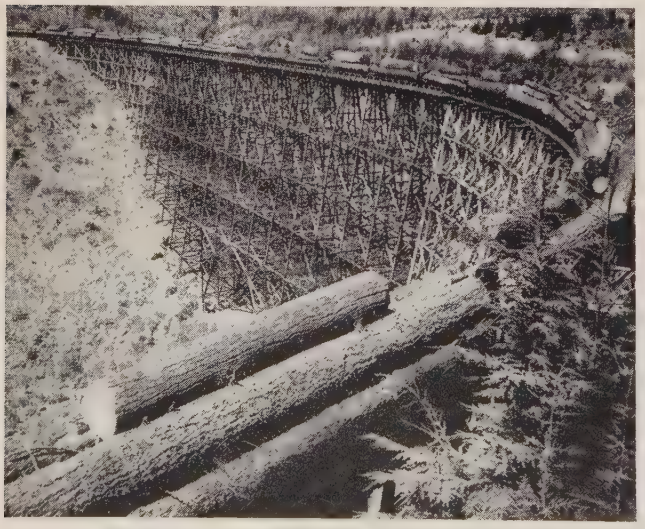
Rapid development of new equipment, or improvements in old, such as pulpers, defibrators, savealls, of the semi-chemical pulping process, improve yields of pulp from fiber as well as produce greater recovery of former waste.

The Pacific Coast paper and pulp industry's present status is excellent, technically and physically, as well as financially, and it has a great future as markets for pulp and paper and allied products stabilize, and new markets are opened up for products resulting from your most excellent research.

The last paper on the opening program was given by H. R. Murdock of Robert and Company Associates, who was formerly Chief of the Pulp and Paper Branch, National Resources Section, G.H.Q., Tokyo, Japan.

The Natural Resources Section was established to aid General Headquarters on various phases of Japan's economy. The land area is small, the four main islands being the only territory retained after the war, and is over populated. The forest resources are not adequate although 68% of Japan is considered to be forest land compared to 16% suitable for agriculture.

Prior to the war, most of the paper production was confined to one company which has since been broken up. The mills are obsolete and operations were hampered by a complete lack of cooperation on a technical basis. The formation of "Japanese TAPPI" based on the organization of the Technical Association, had an immediate response,



Train of logs crossing a bridge which is 235 feet high at the center and 1130 feet long

Sawlog being barked by hydraulic barker before it enters sawmill

and this group has become a principal factor in improving process and mill efficiency.

In addition to the well recognized methods of paper manufacture, Japan has a large number of homes and factories, about 12,000, making handmade paper. These units are most important to the country's economy, because the other mills are small and out-dated, and also because they are needed to support a sizable part of the population.

The pulp and paper industry is at least 15 years behind the rest of the world, and the occupational forces have assisted the industry by improving the existing processes and advising improvements in operations and management.

Harold S. Foley Addresses Wednesday Luncheon

R. J. LeRoux presided at the luncheon and introduced Harold S. Foley, President of the Powell River Co. Ltd., and Chairman of the Canadian Pulp and Paper Association who made the following remarks:

"Mr. LeRoux was kind enough to ask me to come down here today as your guest. It is a pleasure to see and meet so many of you gentlemen who play such a vital part in the pulp and paper industry on this continent.

"TAPPI is an outstanding organization. Its contributions to the progress, prosperity, and security of our industry have set an enviable example.

"We of Powell River are pleased that the late Robin Bell-Irving and Harry Andrews, executives of our company, helped organize the Pacific Coast section of TAPPI back in 1929. Although the Canadian Pulp and Paper Association has its own West Coast section now we are still keenly interested in your activities and welfare, as you are in ours.

"I have never really given much thought to the extent of exchange of ideas and information; the free discussion of research and engineering problems, nor to the mutual feeling of confidence which exists in our industry, until three weeks ago.

"At that time Dr. Maas, Director of the Pulp and Paper Research Institute of Canada, a member of our National

(continued on page 44 A)

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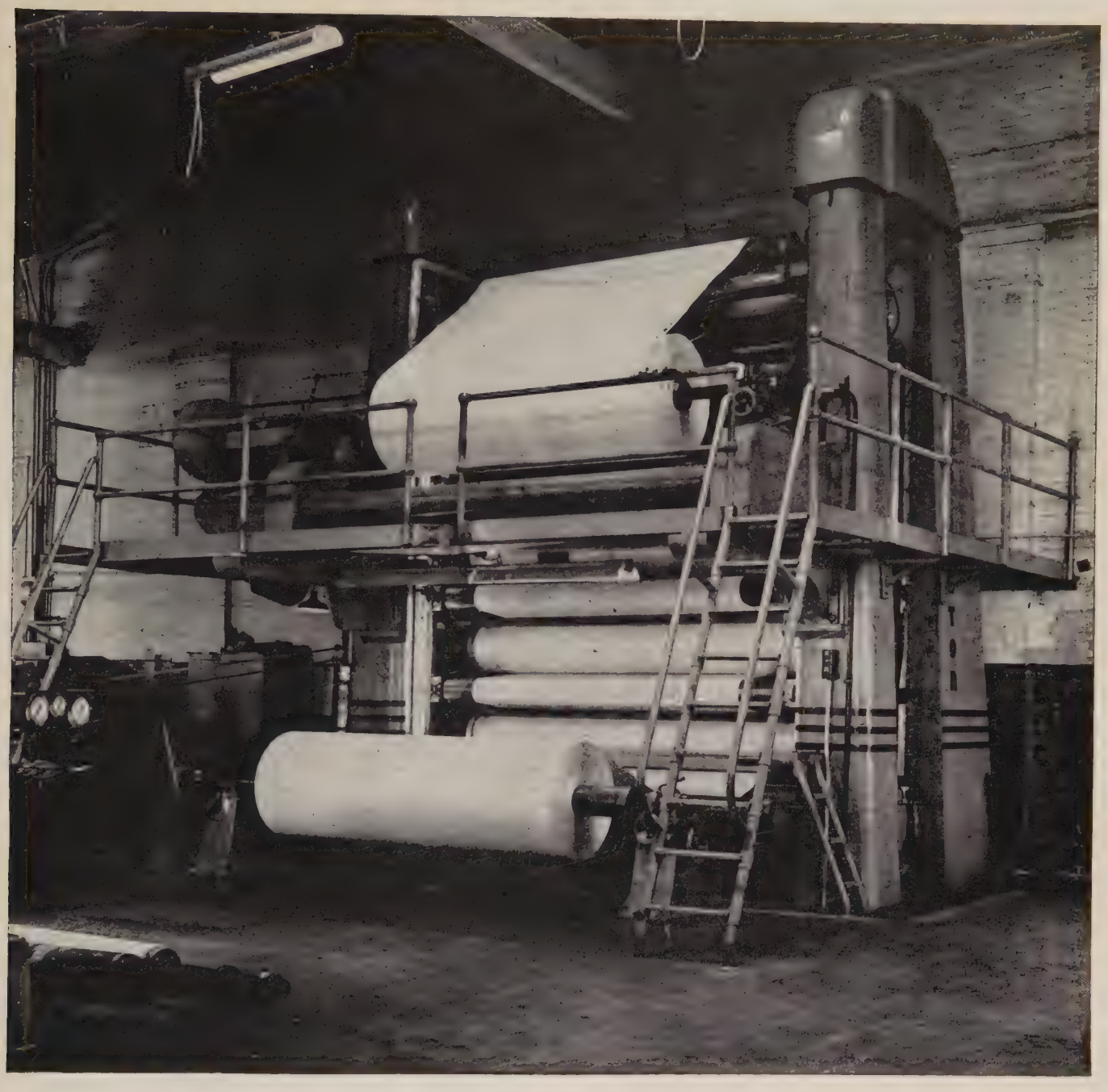

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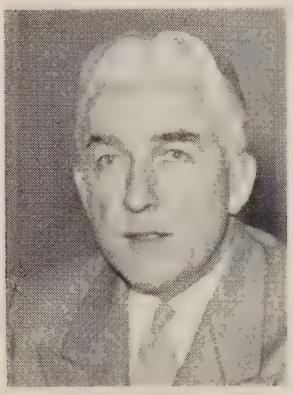
SINCE A 1883

(continued from page 42 A)

Research Council, and Dean of the Department of Chemistry at McGill University, was here on the Coast. We were discussing research and progress in our industry as compared to other industries. During the discussion he reminded me that many industries on this continent are averse to the exchange of ideas and information; technical and research



Harold S. Foley, President, Powell River Paper Co.

E. W. Tinker, Executive Secretary-Treasurer, American Paper and Pulp Association

men from one organization are not welcome visitors to a competitor's plant—somewhat of an iron curtain theory rules.

"The freedom which exists in our pulp and paper industry, like the freedom in our two countries, is often taken for granted. Like most of the good things in life, we sometimes accept these freedoms without realizing their value or the responsibility which we must assume along with them.

"I sincerely hope that we will always have the unique freedom and fellowship that is the spirit of TAPPI and our industry, and above all the freedom enjoyed in our two countries.

"I am not a technical man. It has been quite a problem to select an appropriate subject for today's talk. I thought you might be interested in market conditions, or the interdependence of Canada and the United States. However, the more I thought of Dr. Maas' outline of the freedom in our industry the more I was convinced that he had given me a suitable subject—Free Enterprise.

"The words free enterprise have been used so frequently of late that they have lost their original impressiveness, and it is not my intention to take you over this well worn ground today. I am however going to give you my ideas of the relation of free enterprise to technical activities in our industry.

"I am convinced that our system of free enterprise has been largely responsible for bringing about the free exchange of ideas which exists in TAPPI. Executives and members of this association were able to convince management that TAPPI and its principles were sound. As a result technical skill has been free to operate without regimentation in the testing grounds of pulp and paper industry. Under our system risk capital has been provided for your new ideas, for expansion, and for new products. This is fine—this is the way it should be, because research today means industrial progress tomorrow.

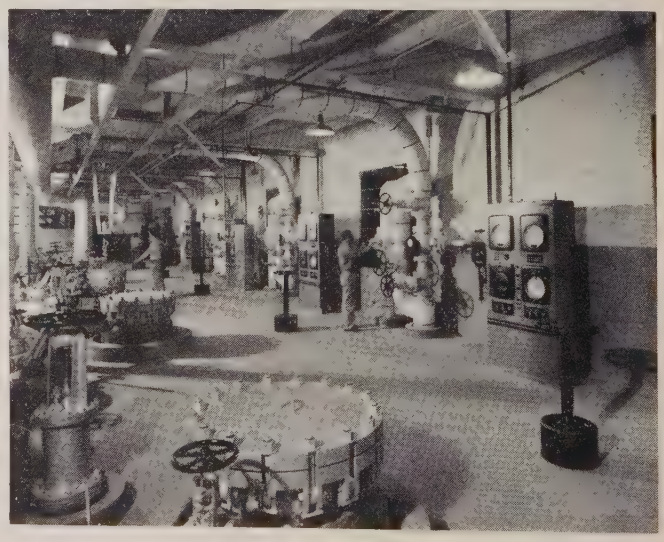
"However, virtually every company today is, or should be actively engaged in tightening up, overhauling their affairs, and taking stock, because our system of free enterprise is being challenged. We are out of the period when any type of an operation could produce and sell any kind of product, and make a profit. To be able to operate profitably in this period of price adjustment and reduced volume, management, with your help must cut costs and be able to sustain a reasonable volume.

"During the war and postwar period emphasis was on production. Capital or operating costs did not count. Today we must trim our sails to the winds of readjustment for once more we are faced with the homely and simple fact that low costs are an essential part of our system. Low cost production is born on the drawing tables and the testing laboratories of our companies. It is achieved through sound thinking, planning and team work, in every branch of our industry. Those fields which are of prime interest to you can contribute immeasurably to cost reduction.

"Engineering, design, development, research, and management have the perfect opportunity for pooling their talents, if we have any. Each of us should know exactly what the other is doing. By this I mean that through team work we tackle the job in an organized way, bringing out the information needed for far sighted planning and decision. We need research—not intuition; facts—not fancies. Your groups should present ideas to management in a way that can be clearly understood, and, incidentally, it's a good idea for you men to have a speaking acquaintance with the sales and financial departments. Remember always that research and engineering now, as never before, must include as much economic horse sense as it does scientific principle. The movie producers have a name for economic horse sense that sounds good to me—it's called 'Box Office Appeal.'

"In today's modern industrial activity there is no place for the man in an ivory tower—you must contact all departments in the organization for they must have confidence in you and your ideas. The ideas you present must be commercially sound or they are useless to management, whose thinking is obliged to be guided by costs and the resulting profit or loss. Free enterprise thrives on profit—without low costs profit suffers or disappears. Without profit our free enterprise system would soon disappear.

"Research, engineering, operations, sales, finance, and management, teamed together under our free enterprise system, will produce an abundance and variety of goods and services on the most economical basis in the world. By this accomplishment our products are brought in abundance within the reach of everyone. Under free enterprise our nations have gone further economically, commercially, politically, and spiritually than any others, and have travelled the distance faster. Free enterprise is the seed of future growth



Operating floor for sulphate digesters at the Weyerhaeuser plant at Longview

(continued on page 46 A)

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It is a fact that Vortraps are used in greater numbers and in more mills throughout the world than all other types of centrifugal stock cleaning equipment.

The Nichols Freeman Vortrap installation in the Weyerhaeuser Timber Company's new Kraft Pulp Mill, Longview, Washington, illustrates the simplicity of design and layout possible with Vortraps. It is to be noted that only the basic, necessary equipment for the production of clean, high grade pulp is employed.

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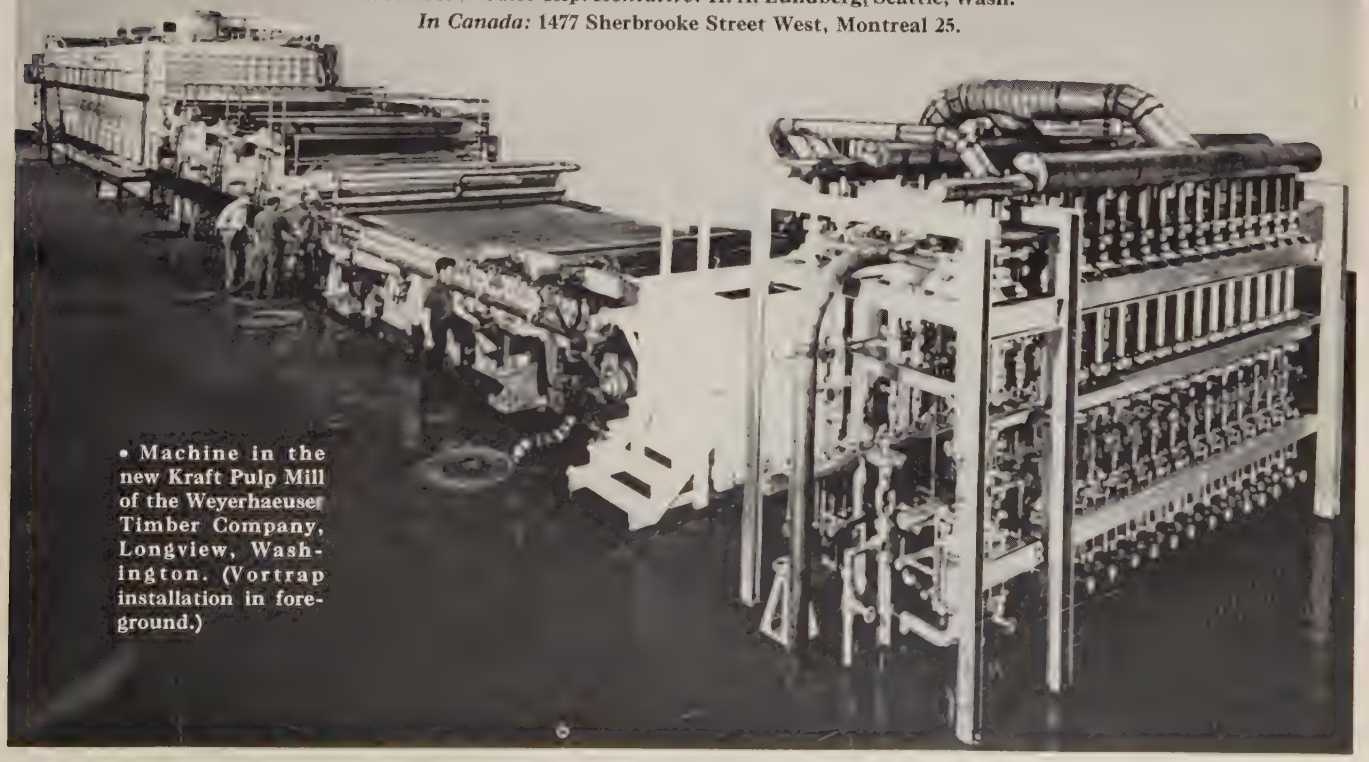


• Machine in the new Kraft Pulp Mill of the Weyerhaeuser Timber Company, Longview, Washington. (Vortrap installation in foreground.)

(continued from page 44 A)

for our industry and our countries. It is the great equalizer, giving every man an opportunity to develop his own initiative.

"Our system has weathered a lot of storms. It has made many mistakes, and will continue to make mistakes. It is not perfect by any means. But it has done a good job and it will do a better one if we keep the machine in good operating condition. You men of TAPPI have an important part in the future success of your free enterprise system.

"Your technical knowledge and skill provides what our system grows and thrives on—low cost improvements, new ideas, and new developments. The thing that makes men free in our form of society is not wealth, nor is it power—it is knowledge, diligently and intelligently applied. This puts a great responsibility on each one of us and as free men we should be as jealous of our responsibilities as we are of our liberties.

"This then, is the thought I would like you to take home with you: I am proud of my responsibilities—if I make myself equal to them they will keep me, my family, and my country, free."

Engineering Meeting

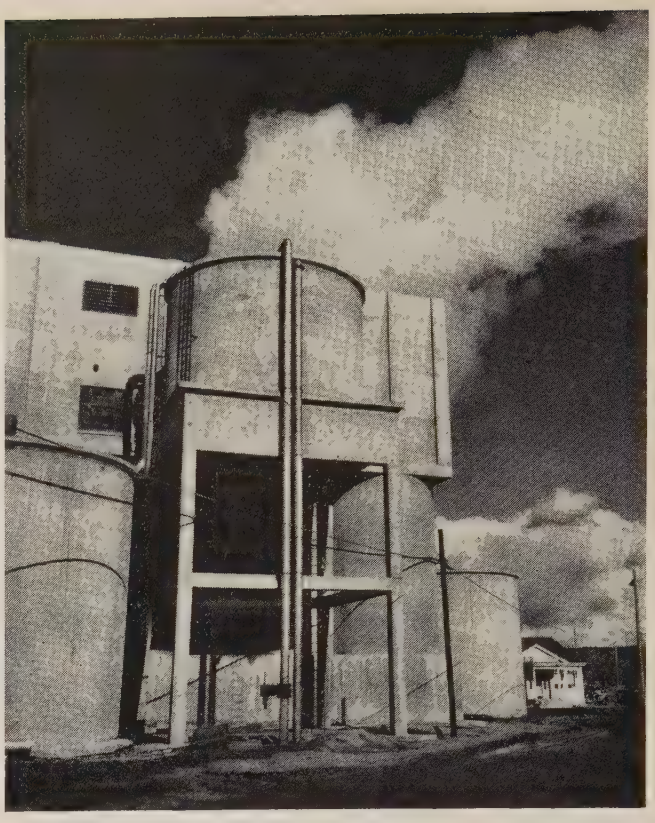
After the luncheon, the engineering program got under way with G. H. Pringle of the Mead Corp., presiding.

The first paper "Corrosion and Corrosion Testing in the Pulp and Paper Industry" by R. A. Huseby and M. A. Scheil of the A. O. Smith Corp., was presented by Mr. Huseby.

The paper was divided into three parts. The first part was a discussion of basic corrosion data which illustrated general corrosion, pitting, galvanic corrosion, intergranular corrosion, stress corrosion cracking, and concentration cell corrosion. These forms of corrosion were discussed and illustrated chiefly from pulp mill equipment. Pitting is a serious failure of many alloys in the pulp industry and it is usually the result of local breakdown of passicity and many factors contributing to nonhomogeneity of the surface. Various heat treatments which produce carbide or other precipitated phases were illustrated to show direct correlation with pitting. The extra low carbon 0.03% maximum type 316 stainless steel has less tendency toward pitting than the regular 0.08% maximum carbon type 316 under various conditions of heat treatment.

The importance of carbon and chromium in stainless alloys as well as molybdenum for sulphite and sulphate service was discussed. The results of field corrosion tests showing the effect of varying molybdenum content in 18–8 stainless steel exposed in calcium base sulphite service shows that at least 2% molybdenum is required to avoid pitting. The relation of chromium content in various type 316 stainless analysis shows in the ammonium base sulphite service better corrosion resistance with higher chromium content.

Deckers in sulphate screen room



Exterior of the Weyerhaeuser sulphate bleach plant

The last part of the paper gave corrosion rates of carbon steel and stainless alloys in the kraft process as used in various parts of the country. In some of the newer types of kraft processing corrosion rates on carbon steel are of the order of 1/4 inch to 1 inch per year. Stainless steels resist the corrosion effect in digesters very well and an account was given of applied liners in service more than two years.

L. E. Hill of the Pulp Division, Weyerhaeuser Timber Co., presented a summary of hydraulic barking.

The large trees found in the West Coast region were formerly cut to cants of sizes which could be cleaned mechanically. This entailed much lost wood, especially when log shape was irregular. Postwar requirements for use of all available wood brings even more irregular portions of trees to the mills. The types of irregularities were listed and the percentage of wood lost in each step of the older method of preparation was given. Hydraulic barking has saved approximately 20% over the mechanical process.

Various present hydraulic barkers and other possible barker arrangements are classified according to movement of wood and movement of the jet of water. A short description was given of fifteen barker types which have been evolved during research or are now in successful operation in mill installations. The summary related barker performance with mill economy and forest utilization and three dimensional models were used to show types and to assist in the discussion of reasons for the success of those types which are currently most widely used.

In the "Paper Mill Engineering and Construction" J. H. McCarthy of the St. Regis Paper Co. described and illustrated certain fundamental steps taken in the preliminary engineering of the paper mill project recently completed for St. Regis Paper Co. at Tacoma, Wash. Such

(continued on page 48 A)

Leaders don't just happen. In most cases, it is the combination of skill, performance and facilities that add up to make one "the leader."

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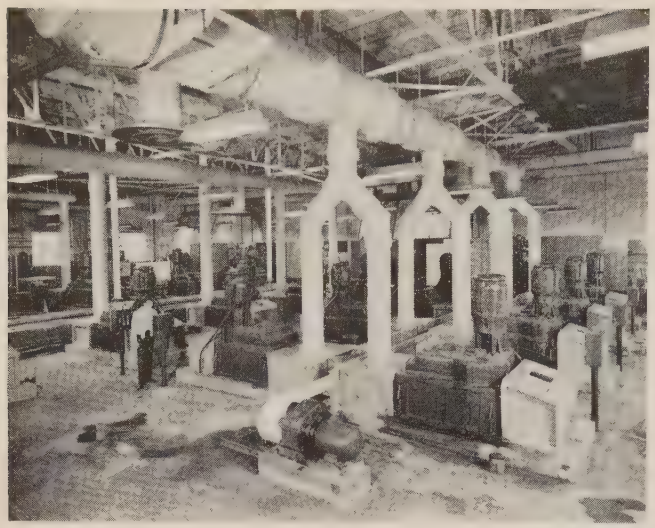

Operating floor of sulphate bleach plant

items as a comprehensive job outline in which code numbers are assigned for use in all phases of the job, a miniature key plan on which all equipment relationship may be seen at a glance, were among those presented and shown.

A discussion of the engineering design to resist earthquake shocks was one of the timely features of this paper, the Puget Sound area having suffered a severe shock since the Tacoma mill was completed.

Mr. McCarthy also presented a review of the materials of construction used in the paper mill structure, some of which are novel and interesting. These features were illustrated with pictures which showed structural and architectural treatment.

A complete description was given of each section of the paper machine and accessories such as jordan installation, fan pump, broke hydrapulper, and the conditioned electrical control room 180 feet long by 20 feet wide. All these items, and many more, were illustrated by photographs and drawings to give an extensive visual trip through the completed project.

Fundamental Research

The second session of Wednesday afternoon's program was devoted to fundamental research. J. L. McCarthy of the University of Washington acted as chairman and introduced H. F. Lewis of the Institute of Paper Chemistry, Chairman of the TAPPI Fundamental Research Committee.

The first formal paper, "Report on Lignin Studies under the Pulp Mills Research Project at the University of Washington," by D. M. Ritter and Joseph L. McCarthy was presented by Mr. Ritter.

The Pulp Mills Research Project was established in 1944 at the University of Washington by about twenty pulp and paper companies located in the State of Washington as an instrument to aid in the development of methods by means of which the discharge of pulp and paper waste materials into water courses and the atmosphere could be avoided. The investigation has been supported to the extent of $50,000 to $60,000 per year. One part of the research efforts has been expended in study of methods which might be immediately applicable for the disposal or utilization of such materials as sulphite waste liquors and the kraft mill odor substances; some of these results have been reported in the literature and other work is in progress.

The second part of the research effort has been concerned with the longer term problem of development of additional useful facts concerning lignin—its removal from the wood, its purification and chemical characterization, its derivatives and conversion products, and its utilization. Study has been devoted to lignin sulphonic acids from sulphite waste liquors, and also to sulphur-containing lignins similar to those available from kraft pulping waste liquors. Methods suitable on a laboratory scale for purification of some of these lignins have been evolved. Their empirical composition as available from Pacific Northwest woods has been determined. Several new methods for characterization of lignins have been worked out and are being applied to lignins isolated under different conditions. Some chemical derivatives of these lignins have been prepared and their properties are being determined. Lignin reactions which may prove to have industrial and theoretical significance are being studied.

"A New Method of Isolating Conidendrin from Sulphite Waste Liquor" by H. B. Lackey, W. W. Moyer, and W. M. Hearon of the Crown Zellerbach Corp., was presented by Mr. Lackey.

A new procedure was reported that has now been found to isolate conidendrin by precipitating it from sulphite waste liquor through the addition of certain organic liquids. The product so obtained represents essentially all the conidendrin present in the liquor and is of good quality. The advantages of this new isolation method are the simplicity of operation, purity of the product, and possibility of working with large volumes of liquor without elaborate equipment. The possibility of utilizing this method of isolation commercially has been demonstrated in a small semiworks plant.

A study of the variables concerned with the precipitation of conidendrin from sulphite waste liquor has been made. These variables include the pH, concentration, and temperatures of the liquor, and the identity and amount of the precipitating organic liquid. The optimum performance was achieved by the use of trichloroethylene to 2.0% by volume of the sulphite waste liquor as it comes from the digester, cooled to room temperature.

The possible usefulness of conidendrin has been explored. As such, conidendrin has not yet found industrial application, however derivatives of it have shown promise as commercial antioxidants and for pharmacological uses.

The importance of the exposed or external specific surface of pulp fibers in imparting optical and mechanical properties to a sheet of paper was indicated in "Surface Area of Fibrous Materials by the Air Permeability Method," by Joseph C. Brown, Jr., of The Institute of Paper Chemistry. It was pointed out, however, that the extent of the area actually used for fiber-to-fiber bonding is probably the more significant quantity. A method of measuring the exposed surface area of the unconsolidated fibers in a

Bleached sulphate stock from decker

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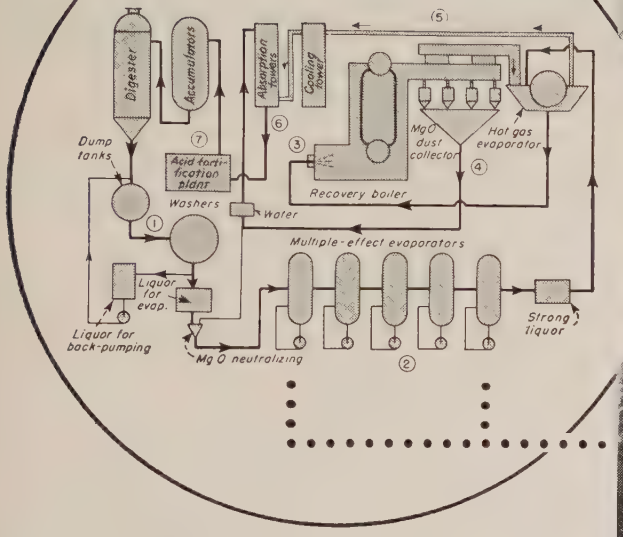
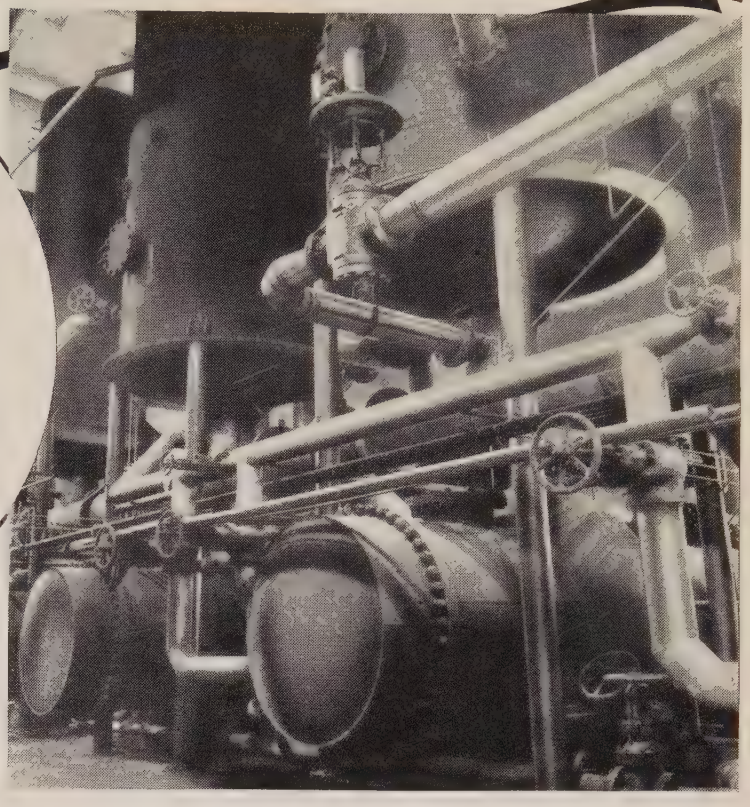
Sulphite waste recovery system COMBATS CORROSION



Flow chart for this new system at Weyerhaeuser Timber Company's Longview, Washington, pulp mill.



All vessels and vapor lines in this evaporator are Lukens 20% Stainless-Clad Steel, built by General American Transportation Corp.

. . . with Stainless-Clad Steel

Recovery of sulphite-process chemicals, elimination of stream pollution, steam for process and power generation—these are the advantages of this new process. It employs magnesium oxide as the base for the cooking liquor, instead of the usual calcium oxide.

Lukens Stainless-Clad Steel, used in the quintuple effect evaporator pictured above, combats corrosion in case liquors and vapors become acid in character. Because stainless steel is only 20% of total plate thickness, the economies gained by using clad steel made it feasible to proportion vapor lines and vapor bodies generously to take care of considerable overloads.

Should your conditions require the protection offered by nickel, Inconel or Monel, Lukens makes a complete line—Nickel-Clad, Stainless-Clad, Inconel-Clad and Monel-Clad Steels. In each, the cladding is permanently bonded to its backing plate. All are available in the extra-smooth sodium hydride finish.

Send for Bulletin 470, giving information on clad steels in the Pulp and Paper Industry, or Bulletin 449, a general bulletin on Lukens Clad Steels. Lukens Steel Company, 501 Lukens Building, Coatesville, Pennsylvania.

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STEELS

SOLID METAL ADVANTAGES WITH CLAD STEEL ECONOMY

(continued from page 48 A)

pad, for comparison with that of the fibers in a sheet of paper, should serve as a means of estimating the surface area utilized for bonding in the paper sheet. The fluid permeability method for determining specific surface of particulate material, which has found use in the field of fine powders, was used in the study with air as the permeating medium. Calculations are based on the Kozeny equation as modified by Carman to allow for the effect of "slip."

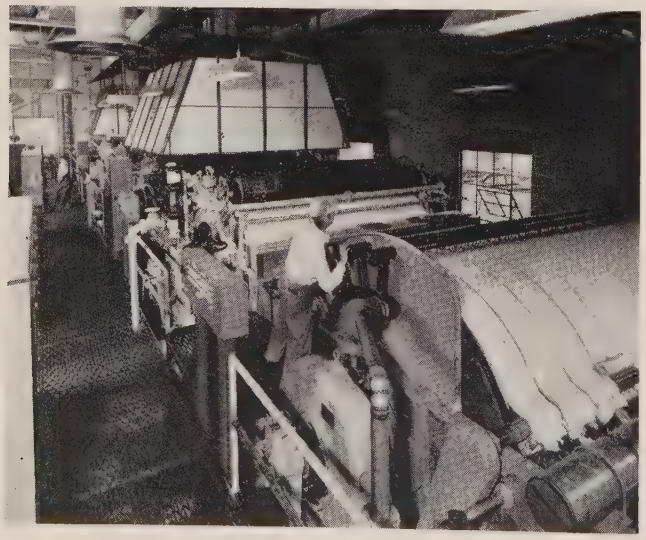
Permeability data for pads of dry unconsolidated fibers, both beaten and unbeaten, were obtained over the porosity range 0.37 to 0.90. Values of specific surface and of the bed constants (K, K_0, L_eL) were calculated from these data, and compared with values obtained from permeability data for handsheets prepared from the same West Coast bleached sulphite pulp. Calculations, using a pore shape factor (K_0) of 3.0, indicate that the exposed specific surface of the unbeaten fibers is 3800 square centimeters per gram. That of the normal handsheets from the same unbeaten pulp is about the same, indicating that the area used for fiber-to-fiber bonding is negligible. For a pulp beaten to a freeness of 610 milliliter Schopper-Riegler, the fibers have an exposed specific surface of 6750 square centimeters per gram, while that of normal handsheets is about 4850. Assuming that the difference between the exposed specific surface of the unconsolidated fibers and of the normal handsheets, as determined by the air permeability method, is a fair measure of the area used in bonding, this bonded area is of the order of 25 to 30%.

For pulp fibers, the Kozeny factor (K) is not constant, but increases with decreasing porosity; the pore shape factor, however, appears to be relatively constant over the porosity range 0.37 to 0.90. The equipment and test methods were described.

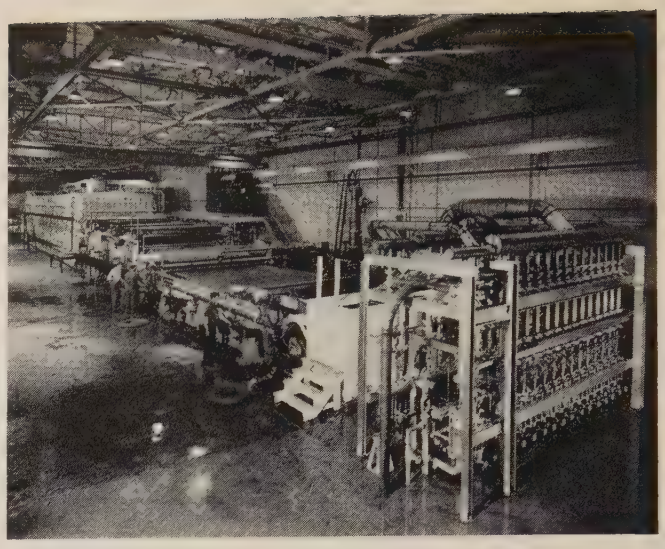
"Recent Developments Relating to the Fine Structure of Cellulose Fibers," by O. Goldschmid, Rayonier, Inc., indicated the recent modifications of the methods upon which the present picture of cellulose fine structure is based. X ray difraction and accessibility measurements indicate that in addition to the amount of crystalline and amorphous material, the size of the crystallite is of great importance for a better understanding of this structure.

Information on the dimensions of the crystallites of various cellulose fibers which has recently been obtained by such different methods as low-angle ray scattering and limiting D.P. measurements was reviewed, and the extent to which the results are in agreement was discussed.

The results of these methods were compared with those recently obtained with the electron microscope in Svedberg's laboratory. It was found that the length of the crystallites of acid-hydrolyzed cellulose determined with the electron microscope was in good agreement with that derived from limiting D.P. determinations.



Oliver washers in sulphate bleach plant



Drying unit for bleached sulphate at the Longview mill of the Weyerhaeuser Timber Co.

The last fundamental research paper "Microscopical Determination of the Arrangement of the Cellulose Crystallites in Basswood," by George J. Ritter, Chemist at the Forest Products Laboratory presented microscopical data, in the form of photomicrographs, on the arrangement of the planes of the indices of refraction of the fibers and the ray cells in wood and also ray data on the arrangement of the cellulose crystallites in the fibers and the ray cells. A correlation of the microscopical and the ray data indicates that the high-refractive index plane is parallel to the lengthwise direction of the cellulose crystallites in both the fibers and the ray cells. By knowing the relationship between the two types of data, it is possible to determine the orientation of the cellulose crystallites in cellulose specimens microscopically and thus avoid the preparation of ray specimens.

Photomicrographs in black and white and in multicolors taken in polarized light indicate that the celllulose crystallites in the fibers are arranged, in general, with their long axis parallel to the long axis of the fiber and crosswise to the long axis of the ray cells.

Shrinkage of cellulose material or wood during drying occurs at right angles to the long axis of the cellulose crystallites in parallel arrangement. Accordingly, fibers should shrink most in their crosswise direction and ray cells in their lengthwise direction. These theoretical predictions on shrinkage of these two structural wood elements are confirmed by actual microscopical measurements.

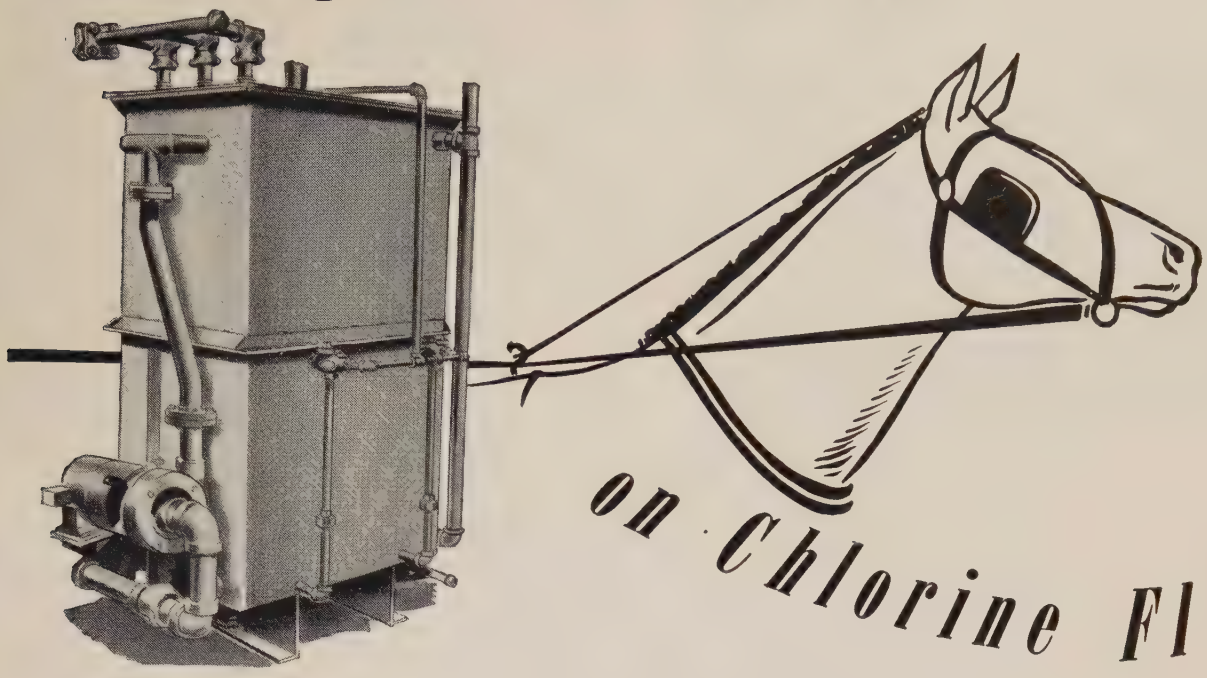
Radial shrinkage of wood ranges from 50 to 60% of the tangential shrinkage; the discrepancy between the two types of shrinkage, in the past, has been explained on the basis that ray cells do not shrink lengthwise, which is the radial direction of the wood, and thereby greatly restrain radial shrinkage. In the light of the crosswise crystallite arrangement in the ray cells, the preceding explanation for less radial than tangential shrinkage of wood is apparently in error.

Sulphite Pulping

At the same time Wednesday afternoon that the Engineering and Fundamental Research Sessions were being conducted, G. H. McGregor of the Minnesota & Ontario Paper Co., presided over the group interested in sulphite pulping. The Shibley Award paper, "The Separation of Dirt from Unbleached Pulp by Centrifugal Type Classifiers,"

(continued on page 52 A)

Putting a Checkrein



on Chlorine Flow

Even as short a time ago as 1930 the methods of controlling and measuring chlorine were quite unsatisfactory. A batch of liquid chlorine was put in weigh tanks. This measured weight was then evaporated and conveyed to the point of use. To use this batch of prepared chlorine gas in a continuous bleaching process required a close control that was just unobtainable with existing equipment.

Variations in temperature and pressure caused erratic gas flow from the evaporator. With a demand of up to 2000 lbs. per hour, reducing valves of that date were inadequate. How to maintain uniform pressure and temperature therefore was a problem tackled by Hooker chemists and engineers.

This problem, in so far as it relates to temperature, was solved by the design of a chlorine evaporator that maintained a constant chlorine gas temperature. This evaporator was patterned after a boiler with the chlorine entering at the bottom through tubes which rose through a hot water bath. Water temperature was regulated by the injection of steam, whose flow was controlled by a solenoid valve and mercoid switch. The switch was actuated by the temperature of the chlorine gas leaving the evaporator.

A baffle plate freed the rising chlorine gas from drops of liquid and dry chlorine gas at uniformly held temperature was collected in a dome or chamber at the top of tubes. From this point the chlorine gas was fed through the necessary control equipment to its place of use.

By means of such improvements in the handling of chlorine, Hooker has continued its close association with the pulp and paper industry. Our purpose has been to make it easier and safer for you to use chlorine. Today, as in the past, the problems you are daily encountering are of concern to us. One basic way in which operating problems are kept at a minimum is in supplying you with uniform high quality chlorine, caustic soda and other chemicals.

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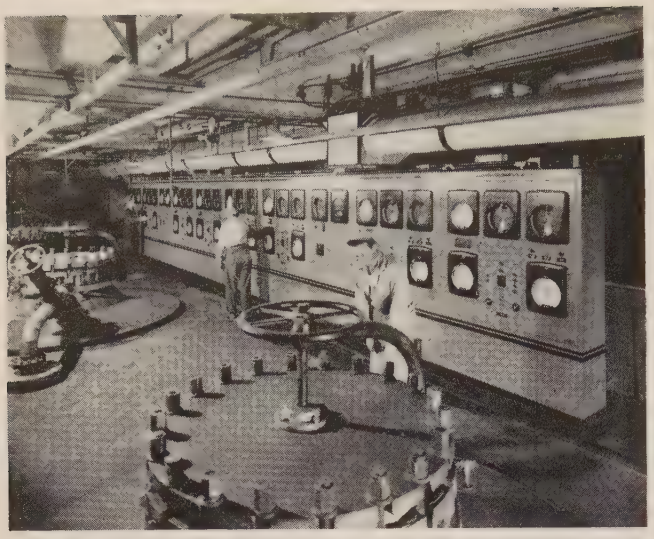


Centralized instrument control panel in the sulphite digester house of the Weyerhaeuser plant

was presented first by the author, Vance L. Reynolds of the Puget Sound Pulp & Timber Co.

It is to be realized that the results of this work, obtained with unbleached sulphite pulp at the plant of the Puget Sound Pulp & Timber Co. may differ from results obtained at other mills where the conditions of operation are not the same. Also, it should be pointed out that this was not intended to be exhaustive study of centrifugal dirt separation. With these reservations in mind, however, there is every reason to believe that the results set forth are indicative of the results to be expected in other similar installations.

The Dirtec and the Vortrap were found to remove dirt from unbleached sulphite pulp in the order of 30% of the specks and 10% of the shives but experimentation indicated that a high positive bleed is necessary. The sumps are ineffectual as settling chambers with unbleached stock, and there was no apparent change in unit efficiency when the capacity was increased by enlarging the inlet nozzle. Although it was not the purpose of this study to critically compare the Vortrap with the Dirtec, results of tests made on both of the classifiers indicated that they are about equal in dirt removing ability, and that they can be so arranged that losses of acceptable fiber can be held to a minimum.

E. F. Tucker, of the Stebbins Engineering & Manufacturing Co. presented the second paper "Digester Linings for Soluble Base Sulphite Pulping."

The use of bases other than calcium for the preparation of bisulphite cooking liquor has been very limited in the past. As a consequence the problem of digester lining specifications has not been given consistent attention. Until a few years ago there was no evidence that the need for such linings would be extensive. Recent developments indicate otherwise.

Linings designed for calcium base cooking rely on the filling of the pores of the brick with precipitates formed from the process for complete shell protection. The linings for soluble base cooking are not readilly made impervious by accumulations in the pores of the bricks and must have a basically different composition. The use of ammonia and magnesia cooking liquor has necessitated some very radical changes in digester linings including the abandonment of the litharge joint.

Linings for sodium, magnesia, or ammonia base cooking may be almost identical as to specification. Considerable operating information on the effects of cooking liquor made with all these bases is now available. Indications are that good success can be expected from the type of lining now being used in several mills.

The lining problem must be considered in relation to over five hundred existing digesters, many of which may be converted to the use of certain types of linings which will be considered for future welded shells. New installations, designed specifically for use with soluble base, may have thinner linings than are now ordinarily used.

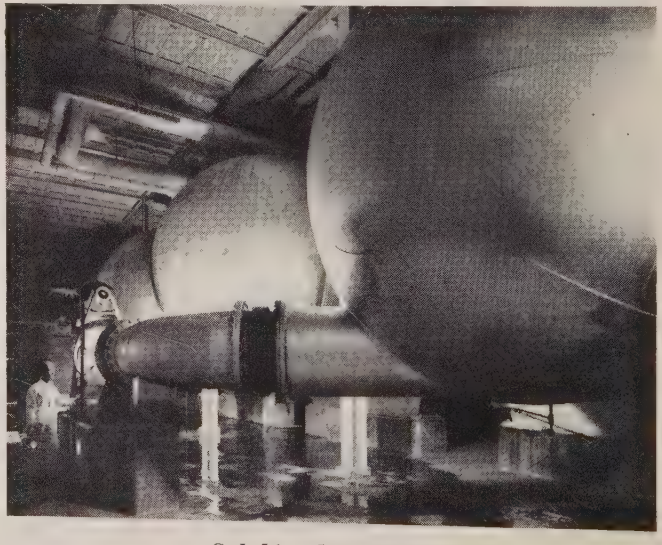
The use of soluble bases is often the first step in the adoption of a complete recovery system. Cooking processes modified to save heat usually result in better operating conditions insofar as the effect on linings is concerned. Linings for use in such processes will be thinner and probably will give longer life. The actual cost of these linings should not be greater than those presently used for calcium base operations.

The third paper, "Magnesia Base Sulphite Pulping—A Process Report" was prepared by R. E. Baker of the Weyerhaeuser Timber Co. and L. S. Wilcoxson, of the Babcock & Wilcox Co. This paper will appear in full in a future issue of *Tappi*.

The last paper of the pulping session "Certain Factors that Influence Delignification in the Acid Pulping Process," by George Richter, Eastman Kodak Co., dealt with some of the factors that play important roles in determining the ease or the difficulty of delignification with bisulphites and with sulphurous acid itself.

It has long been recognized that in acid sulphite pulping ease of delignification can be greatly influenced by conditions that exist before maximum temperatures are reached. Not only can early digestion history interfere seriously with removal of lignin during pulping, but in many cases the lignin remaining in the pulp product becomes more difficult to eliminate in subsequent bleach stages.

The influence of initial high temperatures in the absence of sulphites or high free sulphurous acid solutions is particularly detrimental to subsequent pulping unless such high temperature treatment has been preceded by a sulfonation step. Under some conditions of pretreatment, the lignin is rendered almost wholly inert to later removal by sulphurous acid or by sulphite. On the other hand, when sulphonation is particularly favored in a pre-step, a second stage digestion that allows additional sulphonation or sulphurous acid hydrolysis or both will result in almost complete delignification. The results of this investigation also show that an effective presulphonation can be followed with a high-temperature aqueous treatment of a sort that will in itself ordinarily cause the lignin to become unreactive without appreciable interference in a third stage pulping with sulphite solutions. It is believed that the experimental findings explain to a large extent some of the experiences that are encountered in orthodox pulping procedures.



Sulphite dump tanks

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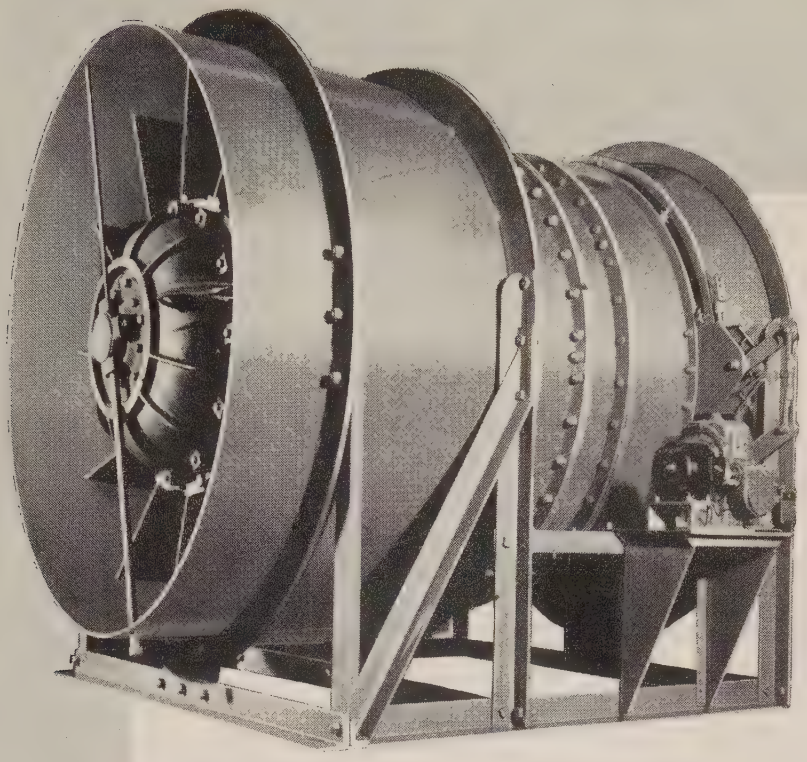

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(continued from page 52 A)

Papermaking Session

The technical program for Thursday was devoted to sessions on papermaking, alkaline pulping, and an exhaustive study of five woods. A. E. Bachmann, Missisquoi Corp., was chairman of the Papermaking Session and introduced Jack E. Jayme, of the Institute of Paper Chemistry, who presented the paper "The Use of Beater and Headbox Additives for the Improvement of Sheet Characteristics," of which he was coauthor with John C. Tongren and Donald T. Jackson of the Hammermill Paper Co.

The materials proposed for addition to pulps and to papermaking furnishes for the improvement of sheet characteristics were listed and their performances compared. A critical survey of recent literature disclosed many contradictory results emphasizing the need for further investigations in this field. The special topic of additives for the improvement of wet strength was not covered since interest in this problem has led to the recent comprehensive literature survey by Adrian and Collins which was recently published in the Paper Mill News.

"Effect of Phenolic Resins on Physical Properties of Kraft Paper," by Parker K. Baird, Robert J. Seidl, and Donald J. Fahey of the Forest Products Laboratory, was presented by Mr. Baird.

The physical properties of phenolic resin-treated kraft paper were determined to note the effects of various amounts and types of resins and thicknesses of paper on the tensile strengths in the dry and wet conditions, air resistance, stretch, density, dimensional swelling, equilibrium moisture content, and water-vapor transmission rate.

Impregnation of the paper with a water-soluble phenolic resin increased the thickness of the paper appreciably above the original thickness of the paper. This also caused a greater percentage increase in the tensile strength in the dry condition in the cross than in the machine direction. In most cases, the strength of the treated paper in the wet condition, equivalent to prolonged exposure to high humidities, was greater than the strength of the untreated paper in the dry condition. Paper with about 15% resin retained, after soaking, at least 80% of its tensile strength when dry.

The dimensional swelling of the untreated and of the treated 9-mil paper in the cross-machine direction was more than twice that in the machine direction. A paper with 14% of water-soluble phenolic resin expanded approximately one-half as much in both length and width as did untreated paper, and paper with 18 and 24% of resin expanded still less. Twenty-four per cent of resin appeared to be the approximate practical limit in regard to dimensional stability since higher resin contents, up to 33%, did not result in significant additional improvement.

Increasing the water-soluble phenolic resin content of the kraft paper decreased its rate of moisture absorption and its equilibrium moisture content. Impregnation with an alcohol-soluble phenolic resin did not alter actual equilibrium moisture content of the fiber substance.

In the next paper "Machine Production Possibilities," J. E. Goodwillie of the Beloit Iron Works discussed the nature of the limitations on paper production imposed by present machines. It does not appear that the speeds of new units are confined to the ranges of the existing machines. There has been considerable progress in the design of headboxes and slices, so that flow is better controlled and arrangements have been developed to aid the formation on the wire. Wire lengths have also been increased.

There is a problem in the couch section and it may be that there is an economical limit on the amount of vacuum that can be applied. The use of primary and secondary couches are one approach, better means of transfer from the wire to the first press another.

Modern press section equipment can be counted on to operate with high degree of efficiency and when properly installed should not impose any speed limitation.

The physical size is a limiting factor on increased drier sections but higher steam pressures have been effective, made possible by the introduction of new materials of construction. It is probably possible to install breaker presses and supercalenders on the machines.

There are no limitations imposed by the reel and winder sections. Further improvements in the drive arrangements will further aid machine efficiency.

The last paper of the session on papermaking was given by Frank H. Abbot III of the Sunset-McKee Co. entitled "Consumer Ideas of Paper Quality."

The manifold printer constitutes an industry which last year billed over 150 million dollars of which 95% of the paper ordered was in mill rolls. Little flat cutting, sheeting, or packaging is required. The packaging in most cases is just a wrapper. Of all the paper used, about 80% is register bond. Of course many other colors, weights, and grades of paper are also used.

Customer satisfaction for all printers includes appearance, brightness, cleanliness, color uniformity, erasing quality, and formation. Both the commercial and the manifold printer are concerned with absorbency, body, bulk, color, hardness, ink receptivity, smoothness, strength, thickness, and uniformity. These things must be known so that the best possible product can be manufactured.

Manifold printers have a few other requirements of paper. Their machine design and the specialized nature of the products demand slight but very important variations in paper quality.

In closing Mr. Abbott mentioned five trends which are developing and noted that it might be well to watch them: (1) There is an increased desire for standardized specifications of splices. (2) Many printers who operate multiple web presses want to purchase paper by the yard rather than the diameter of the roll. (3) Some mills will have to reduce unevenness of tension in rewound rolls causing soft spots. (4) There is a growing need for a good perforation tester. (5) Look for mill roll material control systems to eliminate the header and stencil data on the end close to the core.

This meeting closed with a discussion of quality control in the mill which was led by Mr. Bachmann.

Alkaline Pulping

The first paper of the Alkaline Pulping Session which was also held Thursday morning, was "Sulphate Pulping of Logging and Sawmill Wastes of Old-Growth Douglas Fir and of Certain Associated Species," by J. S. Martin, Chemical Engineer at the Forest Products Laboratory, who was introduced by H. C. Wall, Longview Fibre Co., program chairman.

Samples of Douglas fir of a lower quality than desired for lumber were made into sulphate pulp at the Forest Products Laboratory. The samples included rough-sawed wood from suppressed trees, both young and old growth, and portions of old-growth wood infected with white pocket. Woods with three types of decay, but having equal densities and chemical composition, were pulped. These woods were: (1) stained with incipient decay, (2) with firm rot, and (3) with advanced rot.

Sulphate pulping tests were also made individually on sound mountain hemlock, noble fir, and lodgepole pine which are associated with the Douglas fir, and on a naturally occuring mixture of these species with Douglas fir.

Douglas fir and associated species were all pulped satisfactorily by the sulphate process with chemical requirements comparable to present mill practice. The pulps made from wood containing incipient, firm, and advanced rot were equal in yield and had a lower bleach requirement than pulps from sound wood.

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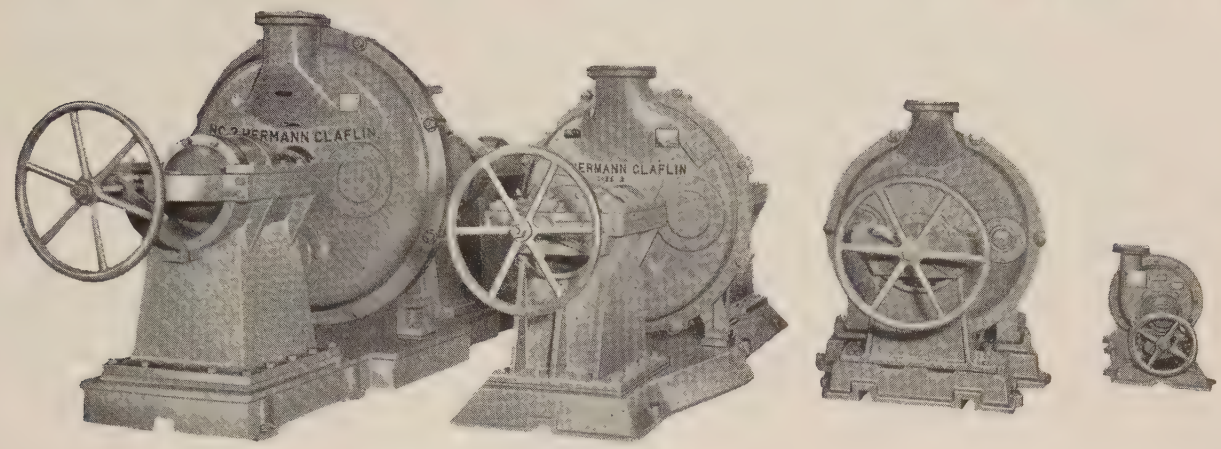

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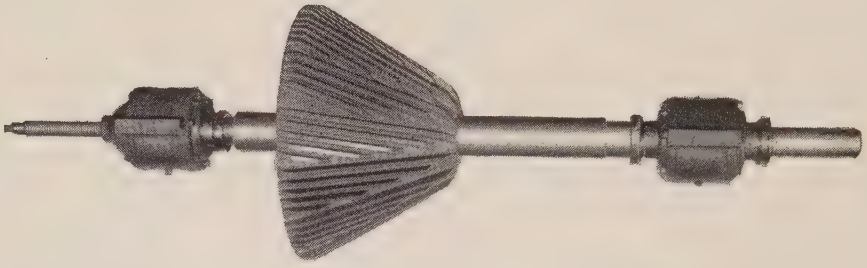

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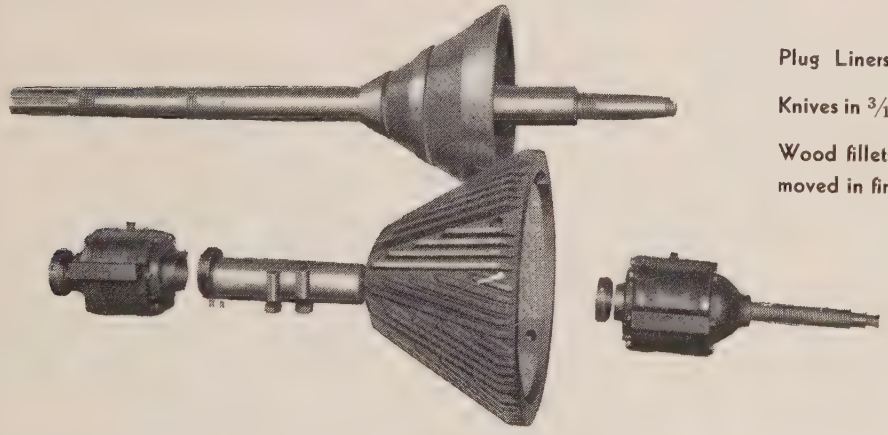

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(continued from page 54 A)

The strength properties of kraft-type pulps from the various woods indicated that: (a) the sound old-growth material would give a slightly lower bursting strength and a significantly higher tearing strength than southern pine; (b) decayed Douglas fir would give a lower bursting strength than the sound wood in proportion to the amount and type of decay, with advanced rot giving a 25% reduction; (c) the mountain hemlock, noble fir, and lodgepole pine would give excellent bursting and fair tearing strength; and (d) material composed of 70% Douglas fir of the various types and 10% each of the mountain hemlock, noble fir, and lodgepole pine would give good bursting and excellent tearing strength and a higher quality than material from 100% sound, old-growth Douglas fir.

The decayed woods had low moisture contents. This would indicate the possibility of a relatively low wood charge and pulp production per unit of digester space.

Alfred Suter, General Superintendent, of the Gaylord Container Corp. mill in Bogalusa, La. presented the paper "Some Experiments on the Centrifugal Clarification of Sulphate Liquor," by A. E. Reed and W. F. Gillespie also of Gaylord.

An experimental Bird Continuous Centrifugal Filter was used to study the separation of lime sludge from white liquor. The unit was 18 inches in diameter and 28 inches long. A white liquor rate of 10 g.p.m. and a product of satisfactory clarity were necessary for acceptable operation. The filter was set up to be fed unclarified green liquor and causticized liquor.

Preliminary tests were made on causticized liquor followed by a continuous running period on mill slurries during which time a rate of 10 g.p.m. centrifuged liquor was maintained for 263 hours. Final tests were made on slurries held at constant composition to study the effect of feed rate and feed temperature variation.

At a rate of 10 g.p.m., if the other variables are held constant, the clarity of centrifuged liquor is about equivalent to tray clarified liquor, however, the latter can be more easily clarified by secondary clarification.

At a liquor rate of 10 g.p.m., variation in per cent solids in the feed up to 11% has very little effect on the clarity of the white liquor. Above 11% a slight variation in per cent solids in feed has a large effect on the white liquor clarity.

With other variables constant, the per cent solids in the centrifuged liquor increases with decreasing temperature. A temperature change from 195 to 165°F. doubled the per cent solids in the white liquor.

Maintaining a feed temperature of 186°F., a rate of 10 g.p.m., and per cent solids in the feed at approximately 9% the other variables affected the white liquor clarity as follows: (1) Increasing available CaO above 3% increases the per cent solids in the centrifuged liquor; (2) Activity of the white liquor has no appreciable effect on its clarity; and (3) Green liquor solids in the causticized liquor are not effectively removed in the centrifuge.

Attempts to clarify green liquor in the centrifuge were not successful. With 0.0344% solids in the feed and at a rate of 6.21 g.p.m., 83.3% of the solids remained in the liquor.

"The Relation of Kraft Pulp Qualities to the Wood Properties of Douglas Fir" by R. N. Hammond and P. S. Billington, Weyerhaeuser Timber Co., was presented next by Mr. Hammond.

Douglas fir logs in the following growth classes were selected and evaluated: 350 year old slow growth; old rapid growth heartwood (plywood veneer cores); 95 year old growth; 85 year slow growth; 50 year old medium growth; 40 year old slow growth; 30 year old rapid growth. The samples were evaluated as to average rate of growth, percentages of bark, sapwood, and springwood, wood density, and chip density. The woods were all cooked identically to give pulps of from 14 to 17 Permanganate Numbers. The yields varied roughly with the percentage of sapwood. Burst, fold, and sheet density varied directly with the percentage of springwood, and the tearing strength inversely so. The alpha-cellulose was definitely lower in the pulps from the woods younger than 85 years old. The young woods produced pulps which bleached to a higher brightness under the same bleaching conditions, but also suffered slightly more strength degradation.

This paper was then followed by a round-table discussion on bleaching which was led by J. V. Savage of the Crown Zellerbach Corp.

Comparative Pulping Studies

The third session conducted on Thursday morning, September 15, was devoted to a series of papers on the pulping of Douglas fir, western red cedar, western hemlock, loblolly pine, and black spruce. H. F. Lewis, the chairman introduced first, J. M. McEwen of the Weyerhaeuser Timber Co., who presented his paper "Sources of West Coast Pulpwood."

Pulp mills on the West Coast have operated principally on hemlock logs with smaller amounts of white fir and Sitka spruce being used. The present trend is for fuller utilization of material that was formerly logging or lumber mill waste. Sulphate mills are turning to Douglas fir, but its heartwood cannot be satisfactorily pulped by the sulphite process. West Coast logging in a sustained yield operation is by clear cutting of successive areas, not by selective cutting. Seed blocks are left to provide natural reforestation. Considerable pulpwood is made available by prelogging and relogging. Preloggings consist of cutting the small trees in an area with light equipment before they are damaged by the main logging operation. Another type of pre-logging which may contribute more pulpwood in the future is the thinning of second growth stands to give the remaining trees more room to develop. Relogging is the salvaging of logging wastes with light equipment. Some mills have to provide wood room facilities for barking and chipping whole logs, cord wood, and waste slabs; as well as handle clear mill waste.

Mr. McEwan was followed by Harry F. Lewis. His paper, "The Significant Chemical Components of Western Hemlock, Douglas Fir, Western Red Cedar, Loblolly Pine, and Black Spruce," reported on a study that had been made of the chemical components of selected samples of wood. Douglas fir and loblolly pine are characterized by higher alpha-cellulose and lower hemicellulose B contents than are the other three woods. The three western woods are lower in pentosan than is the case with the spruce and pine. An unusually high percentage of the uronic acid content of the Douglas fir remains in the alpha-cellulose isolated from that wood. Western red cedar is characterized by the high lignin content of the extractive-free wood and by the high extractive content of the wood.

"The Comparative Pulping of Western Hemlock, Douglas Fir, Western Red Cedar, Loblolly Pine, and Black Spruce," by W. F. Holzer and K. G. Booth of the Crown Zellerbach Corp., was the third paper of the series.

The five wood species were pulped by the Central Research and Technical Department of Crown Zellerbach Corp. in this study of pulpwoods carried out in conjunction with The Institute of Paper Chemistry. Both kraft and sulphite pulps were prepared from Douglas fir, western hemlock, western red cedar, eastern black spruce, and loblolly pine.

The selected logs were hand-barked and chipped in commercial chippers, then air-dried. Kraft cooks were made in an experimental rotary digester to a TAPPI permanganate number of 30. Hemlock was the slowest pulping species, while eastern spruce pulped quite easily. The other

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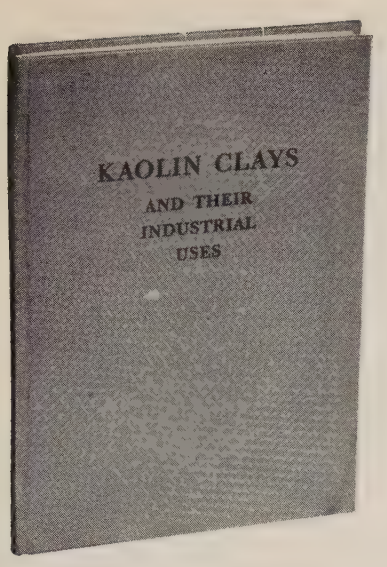
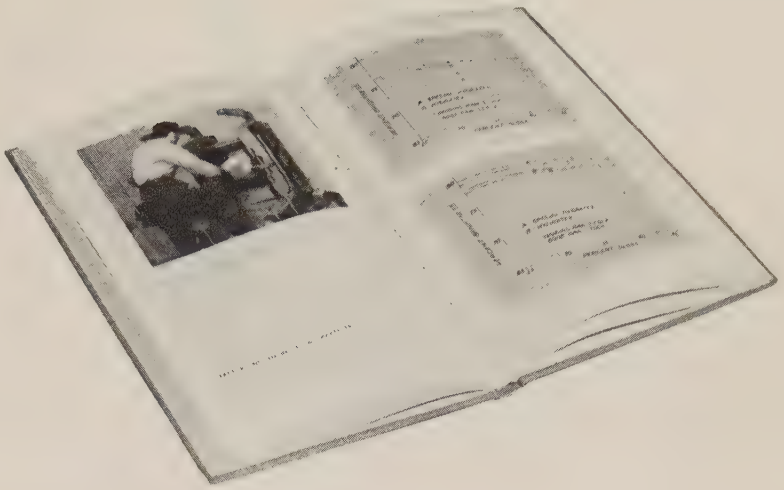


Typical pages from "Kaolin Clays and Their Industrial Uses" in the section devoted to coating grade clays.



New 144-page Reference Book

"KAOLIN CLAYS

AND THEIR INDUSTRIAL USES"

A COMPREHENSIVE REVIEW OF THE TECHNOLOGY OF PRODUCING, REFINING, TESTING AND USING CLAY

Here for the first time is a practical reference book on Kaolin clay. It includes up-to-the-minute technical data on both coating and filler clays . . . with easy-to-read charts and tables . . . and numerous photographs.

One complete section of this 144-page book, comprising six chapters, deals with the use of Kaolin, or China, clays in the paper industry. The section opens with a general description of the function of clay in papermaking, followed by a chapter on the physical characteristics of paper grade clays, such as abrasiveness, brightness, particle size, and viscosity. The tests used to evaluate these and other properties are described and the results interpreted. Subsequent chapters discuss in detail filler grade clays, coating grade clays, the clay content of paper, and clays in wall paper.

"Kaolin Clays and Their Industrial Uses" is the result of several years of preparation and research by the technical staff of the J. M. Huber Corporation in its New York, Georgia and Texas laboratories and plants. Executives and technicians in the clay-consuming industries may obtain a copy by writing today on company letterhead.

Among the subjects discussed in "Kaolin Clays and Their Industrial Uses":

- Uses of Clay in Paper
- Physical Characteristics of Paper Grade Clays
- Filler Grade Clays
- Coating Grade Clays
  - Significance of Particle Size
    - Covering Power
    - Gloss, Brightness and Wax Test
    - Brightness Loss Due to Calendering
  - Factors Influencing Flow Characteristics
    - Clay-Water Systems
      - Effect of Mineralogical Composition
      - Effect of Fineness
      - Effect of Particle Shape
      - Effect of Chemical Treatment
    - Clay-Adhesive Mixtures
      - Typical Starch and Casein Colors
      - Varying Ratios of Clay to Adhesive
    - Rheology of Clay-Coating Systems
- Clay Content of Paper
- Wall Paper Clays

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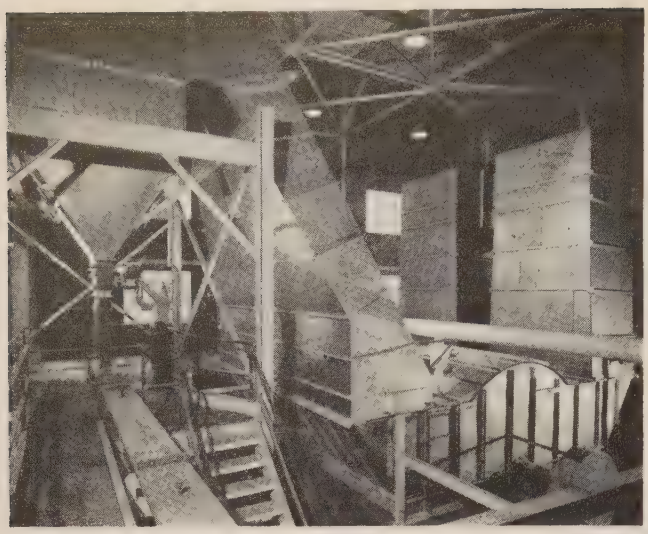

Flue ducts from MgO recovery boilers

three species were intermediate, and quite close in ease of pulping. Hemlock, spruce, and pine yields were quite similar, while fir and cedar gave much lower yields. Eastern spruce had shorter fibers than the other four species which were quite similar in fiber classifications. Cedar pulp gave the highest bursting strength, followed closely by spruce and hemlock, with Douglas fir and loblolly pine giving much lower values. The order of decreasing tear resistance was substantially the reverse of the bursting strengths.

The sulphite pulps were prepared in an experimental digester fitted with forced circulation and indirect heating. Calcium base acid was used for cedar, hemlock, and spruce but sodium base acid was necessary for the other species to prevent burning. Higher temperatures and longer cooking cycles were needed for cedar and Douglas fir to obtain pulps with TAPPI permanganate numbers of 15. Yields of pulp were substantially the same. Fiber classifications were closely similar for all pulps except the shorter fibered spruce. The orders for decreasing burst and tear strengths were nearly the same as in the kraft cooks. Hemlock and eastern spruce are the only two of these five species normally used in sulphite pulping, and the other three species produced quite dark pulps in these cooks.

In "The Pulping Characteristics of Selected Pulpwood Species" Dr. Lewis continued the discussion by commenting on the chemical and physical characteristics of the five pulpwood species. He noted that hithertofore basic information on these aspects had been lacking.

Few significant differences were found in the chemical study of fir, hemlock, spruce, and pine, but the red cedar was high in both lignin and extractives. Unless there is some unusual component capable of affecting the pulping properties of the fir and pine adversely, it does not seem probable that the composition of the wood plays any part in explaining the physical properties of the pulps.

Douglas fir shows an abrupt transition from springwood to summerwood in contrast to the rather uniform cell wall thickness of hemlock. Fir and pine pulps show from 20 to 25% less fibers per gram than do spruce, cedar, and western hemlock.

An investigation of the distribution of cellulose molecules of the species studied showed no appreciable differences. However, the methods used may not be sufficiently sensitive to show them up.

Fir and pine have low specific surface areas, the other three higher with cedar the highest. The area increases in regular fashion with time of beating and freeness. The bursting strength apparently is related directly with the surface area.

X ray pictures show Douglas fir to have an unusual orientation of the cellulose crystallites which affects its papermaking properties. The poor bursting strength of fir appear to be associated with the shape, wall construction, and spiral thickening of the fiber, with the low fiber count per gram of pulp, low specific surface area, low apparent density, and the high degree of orientation of the crystallites. With exception of x ray evidence on orientation, the same may be said of pine.

The papermaking properties of Douglas fir were further investigated by W. F. Holzer of the Crown Zellerbach Corp. and H. F. Lewis and reported in their paper "Comparison of Springwood and Summerwood Fibers of Douglas Fir."

The very prominent annual rings typical of Douglas fir wood caused by an abrupt change from springwood to summerwood suggested a study of these separate fibers. Separation was achieved by hand splitting the wood. In kraft cooking the summerwood pulped much more readily. Summerwood pulp appeared woolly and bulky as compared to springwood. In beating both pulps dropped in freeness at about the same rate, but the summerwood gave bulky sheets with rough surfaces, low burst, extremely high tear, and showed little cutting on microscopic examination, while the springwood gave the opposite, hard dense sheets with smooth surfaces, high burst with poor tear, and extreme cutting of the fibers.

Further tests showed that the summerwood pulp, beaten 40 minutes, had, except for freeness and tear, almost identical properties to the unbeaten springwood including sheet density, burst, specific fiber surface, and fiber length. This is suggestive of the relation of certain sheet and fiber properties and the physical test of paper.

An examination of these fibers by means of x rays showed that the summerwood fiber had an unusually high degree of preferred orientation while the springwood had a very low degree of orientation. This property correlates well with the conception of the effect of molecular orientation on fiber properties and the actual properties as determined by their study.

It is to be noted that the previously cited papers together with several others concerned with the pulping of the five woods will be published in *Tappi* as a series sometime in the near future.

Luncheon and Last Session

Thursday's luncheon was held in the Main Ballroom of the Multnomah Hotel. Mr. Bachmann, President of TAPPI, introduced Alexander R. Heron, Vice-President of the Crown Zellerbach Corp., the principal speaker. Mr. Heron's address is to be found in the fore part of this issue of *Tappi*.

Following the luncheon, K. P. Geohegan, of The Howard Paper Mills, Inc., and Vice-President of TAPPI opened the last session of the technical program by introducing E. W. Tinker, Executive Secretary of the American Paper and Pulp Association. Mr. Tinker's address "Social and Economic Aspects of the Pulp and Paper Industry" follows.

Speach by E. W. Tinker

"The opportunity to discuss certain aspects of the social and economic characteristics of the pulp and paper industry is appreciated. This is true because the successful operation of the American Paper and Pulp Association in its service to the industry and to the public is dependent upon understanding of the industry's place in the country's social and economic pattern. It is particularly important that you and I as individuals be fully informed with regard to these questions. Further than that, it is the responsibility of individuals connected with the industry to disseminate information that will assure public understanding of the industry and of the industry's problems. The days when major industries of the nation could carry on their operations

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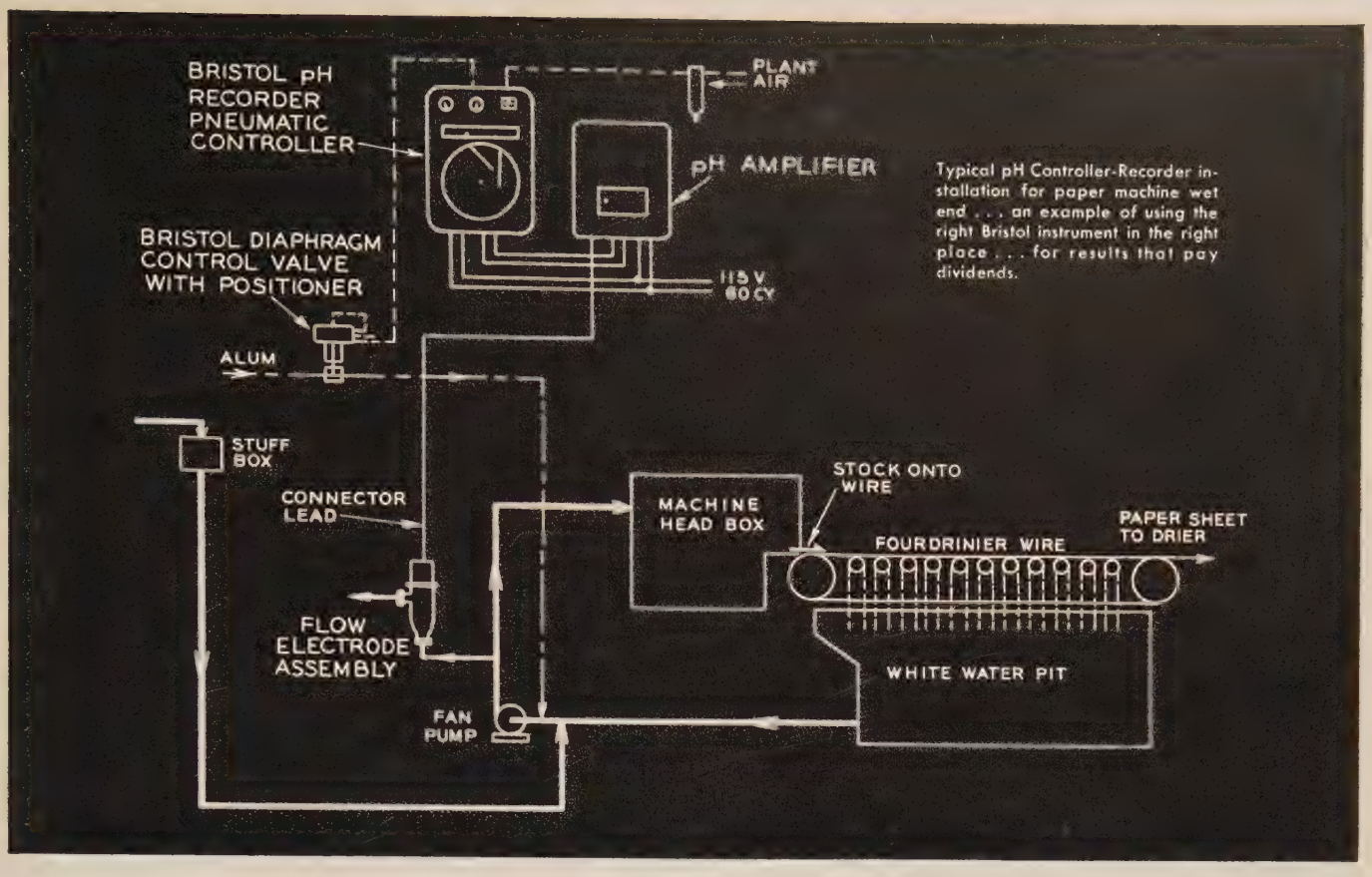

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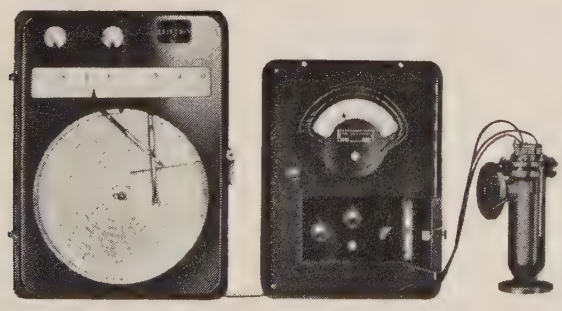

Air-operated Continuous pH Controller, amplifier unit, electrode assembly. Rugged, vibration-proof construction . . . precision potentiometer measuring system . . . automatic reset adjustment. Hundreds of successful installations.

(continued from page 58 A)

without public understanding have departed. Further than that, there is a grave danger that if such understanding is not had, basic but unnecessary changes will be made that will disrupt the normal productive operations and the logical and orderly growth of the industry. We do not stand alone in this situation, but we are one of the country's major industries and we are peculiarly vulnerable to the effects of plans developed by our social and economic planners. You may be sure that with few exceptions the moves made by the legislative and executive branches of the Government have an impact upon the pulp and paper industry and to some extent are of concern to you as individuals. To that extent it is a matter of self interest that knowledge of the industry and of its problems be disseminated. I have a deep appreciation of the valuable contribution of the excellent trade papers of the industry in broadening general knowledge.

"Perhaps by reviewing some of the elements that contribute to justifiable public concern with the welfare of the industry, we can lay the groundwork for understanding.

"The pulp and paper industry is a considerable factor in the employment and payroll situation in the nation. A very high percentage of mill labor is, as you know, of the craftsman or semicraftsman type. The capital investment required per worker unit is the highest of any in the country and wages are relatively high because of the skills required. Among all industries the pulp and paper industry ranks at the top from the standpoint of stability of employment. At the present time employment in the production of paper and paper products and in printing and publishing is over 1,100,000 full time employees who receive over 3 billion dollars annually in pay. In 1947 the total combined sales of these industries was over 10 billion dollars.

"Our requirements for pulpwood approximate 20 million cords a year. It is impossible to measure accurately the number of worker units required to produce this wood because a large percentage of it is the result of part-time operations and particularly seasonal operations on farms. However, it is estimated that it furnishes a substantial part of the livelihood of some 300 thousand workers.

"All in all a very conservative estimate of the employment afforded through the operation of pulp and paper mills would be 1,400,000 individuals. This means that between 5 and 6 million people are dependent upon the industry for a livelihood.

"The above figures do not include more or less independent operators whose activity is dependent upon the well being of the pulp and paper industry. To illustrate, the industry pays approximately 7% of the national bill for freight paid to the railroads. We are the largest customers of the naval stores industry which is a substantial factor in the employment situation of the South. You are well aware of our enormous requirements for chemicals, fuel, and other raw materials.

"Because of the very large capital investments required and the need for accessible supplies of raw materials, the pulp and paper industry is one of the country's least migrant industries. Over the years, because of these factors, large sections in the United States have become, to an increasing degree, dependent upon pulp and paper mill operations for their economic life. I cite the Northern Lake States, a large portion of Northern New England, entire regions in the South, and some of the major watersheds of the Pacific Northwest. The fact of the matter is that there are some 176 communities in the United States that are 50% or more dependent upon the operation of our mills for their continued existence.

"Vast additional supplies of paper and board have resulted from the development of new sources of wood supply in the last twenty years. Since 1929 over-all paper and board capacity has increased by 60%. Each region has shown an increase running from over 10% in New England to 570% in the Southern region. The Pacific Coast capacity increased almost 80% in these twenty years.

"Following is a tabulation of these changes:

Region	*Per cent increase 1929 through 1948*
New England	+ 10.8
Middle Atlantic	+ 22.6
South Atlantic	+119.6
Lake States	+ 40.8
Central States	+ 23.8
Pacific Coast	+ 79.3
Southern	+569.6
Total United States	+ 60.2

"I have no doubt that you are aware of the position of the paper industry in the scheme of things. However, at the risk of repetition, it seems desirable to place before you some of these major considerations as a reminder that the industry is of great importance in the national economy.

It is insufficient for you and I who live in intimate contact with the industry to have this information because it is more and more essential that public understanding be had. Certainly we should expect that communities wholly or in part dependent upon our operations be fully informed. It will be no news to you that there is a strong trend toward centralization of public controls and a growing inclination to legislate the conduct of industry affairs. If these trends are not reversed the cold hard fact is that local authority, with its intimate knowledge of local conditions, will be frozen out of the picture and management will be compelled to give more and more consideration to the risks involved in plans for expansion and development or even in normal operations with the ever increasing threat of unwarranted public controls.

"While it is unpleasant to think of, it seems necessary that you and I as employees of industry recognize the fact that somewhere along the road we have done an extremely poor job in selling industry to the public as a benefactor. In general we live in an atmosphere saturated with the socialistic idea that private industry is something in the nature of a public enemy and requires shackling in one form or another to protect the public interest. In my opinion, this situation has been brought about because of a reluctance, and a natural one, on the part of management to take the public into its confidence by keeping it fully informed of the industry's problems, its merits, and its benefits.

"If there are five or six million people in the United States dependent directly upon the operations of the pulp and paper industry, this should be a matter of general public information and yet I am constantly surprised and disappointed at the lack of knowledge and appreciation on the part of individuals, and particularly individuals in Washington, to whom the welfare of our industry should be a matter of major concern.

"Very recently I had an opportunity to discuss with a group of faculty members and graduate students, at the University of Michigan, the subject of governmental participation in conservation moves. I presume I was given this opportunity because the pulp and paper industry uses large quantities of our natural resources and particularly timber. I made the statement then and I repeat it now, that to my knowledge there is not a company in the pulp and paper industry that is engaged in the manufacture of pulp that is not making plans for a permanent supply of wood to maintain their operations in perpetuity.

"It is inevitable that the pulp and paper industry will lead the way in forest conservation in the United States and unless the ability to plan for the future that has been so characteristic of executives in the industry in the past

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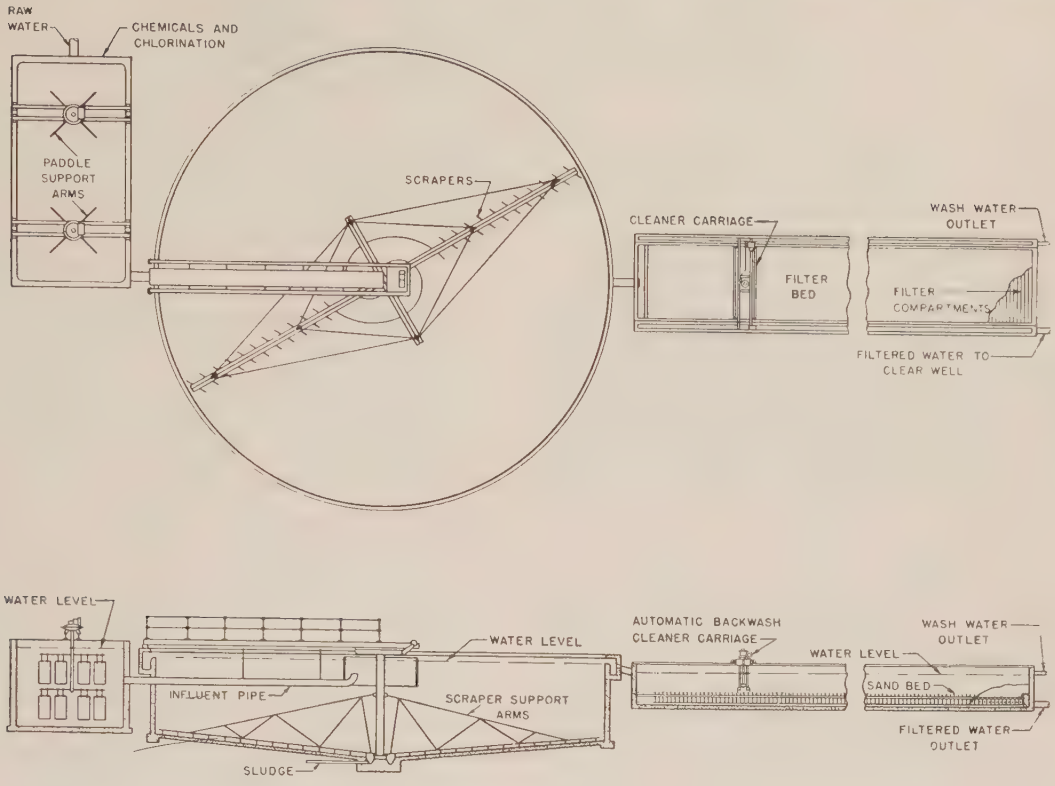
WATER AND WHITE WATER TREATING EQUIPMENT BY HARDINGE



FLOCCULATING EQUIPMENT

Slowly rotating paddles hold solids in suspension—create optimum flocculating conditions. Usually followed by a clarifier in raw water treatment as shown in the typical water treatment flow diagram above. Bulletin 35-C-26.

CLARIFIERS

In the circular model, double-spiral or cut-flight scrapers remove settled solids quickly at the tank center. The rectangular model is designed for limited spaces or where sludge delivery is desired at one end of the tank. For removal of settleable solids from waste water and mill water supply. Bulletin 35-C-26.

Both the Hardinge Clarifier and the Hardinge ABW filter may be used alone when conditions permit.

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has suddenly disappeared, the expansion of this industry or its stability will never be curtailed because of a shortage of raw material in the form of wood. I expect that most of you know this is true but I would hazard a guess that there are employees in your own companies that have fears with regard to tenure of their jobs because of propaganda with respect to devastation of our forests.

"Perhaps this is a good illustration of what I have in mind when I say that it should be a requirement that you and I not only be posted in these matters but that we see to it that others are equally well informed.

"No statement discussing the social and economic aspects of the pulp and paper industry would be complete in these modern times without relating the industry's position to national and international affairs. The pulp and paper industry, as well as other industries, has great difficulty in obtaining understanding in Washington circles. It appears to be the fashion to view industry contacts and consultations with suspicion and to undertake them with reluctance. The situation is not particularly different from that which existed during the war when the industry so laboriously struggled to get appreciation of the facts with regard to the essentiality of its products and the requirements that would have to be met if these products were to be produced.

"Within the last month I listened to a presentation by three Congressmen from the State of Washington to the Administrator of the Economic Cooperation Administration and an exceptionally effective job was done in this particular instance. There was no room for doubt that these gentlemen knew the facts with regard to the situation. If the same knowledge and understanding were more general it would be reflected in facilitating the industry's operations and expanding the public benefits that would accrue. It is an odd situation but those of us who make a study of these broad questions and particularly governmental relationship cannot but be impressed with the close working relationships that exist in other democracies compared with the reluctance to accept industry participation in this great democracy of ours. One can only hope that the situation is temporary and that when there is recognition of the social and economic importance of the pulp and paper industry the welfare of the industry will be accepted as essential to the welfare of the entire country and of the workers within the industry, such as you and I.

"A word with regard to the future of the pulp and paper industry in the United States. Given an even break and assuming that the industry will not be disrupted in its natural development there seems to me to be no question of its potentialities. I am not prepared to state whether we will require 30 million tons of paper and paperboard in the year 1960 or 40 million tons. However, I believe it is inevitable that there will be a large increase in our requirements. I know that there are men in executive positions in the industry that have appreciation of this fact. It does not take too long a look back to recognize that the situation 15 or 20 years ago was recognized by the Cullens, the Lukes, the Meads, the Zellerbachs, the Sensenbrenners, the Everests, and many other men of vision. I believe the same vision and the same courage exist today, but today this vision must include consideration of the environment in which industry in the United States will live 20 years from now. A thorough-going program of cooperation between Government and industry in my opinion would be the most stimulating factor that could be conceived of in assuring maximum future social and economic benefits to the people of the United States. We should only strive for understanding that will bring about this cooperation.

"Let me say in conclusion that I believe the Technical Association has a most important function to perform if we are to redeem our responsibility. Certainly the potential required expansion, particularly in the field of the development of new products will not progress without a vast program of research and the applications of the results of research. The continuous process of education through the Technical Association is essential to this development. The responsibility is definite and I have no fear but that it will be redeemed. By the same token the American Paper and Pulp Association has a definite responsibility in assuring that the industry is well and accurately informed with respect to trends, current situations, and of jeopardies to the industry and its employees and dependent industries. It is insufficient to continuously be on the defensive in these matters relating to the industry although it is clear that these day to day jobs must be done. It is a necessity that men of industrial statesmanship and men of vision and courage be given an opportunity through the availability of factual data to judge the future and to act with certainty and intelligence. In this modern day and age no industry can serve the public and meet its requirements unless it has this basic information and knowledge. It seems to me that between the Technical Association and the American Paper and Pulp Association if we do our jobs and do them well the pulp and paper industry has an assured future."

After Mr. Tinker's talk, E. A. Tippetts of the Rayon Division of E. I. du Pont de Nemours and Co., Inc., presented his paper "The Position of Cellulose as a Chemical Raw Material."

Cellulose, nature's polymer upon which the plastics, film, and "man-made" fiber industries were originally launched, is now facing vigorous competition from synthetic polymers. In the plastics field, particularly, cellulose derivatives now account for less than 10% of the United States plastic production, and further loss in position is expected as more "tailor-made" low cost polymers are developed. Likewise, in the nonplastic field, cellulose derivatives face increasing competition and possible loss of percentage position to new polymers.

Rayon (viscose and acetate) and cellophane are the fields in which the battle between cellulose and synthetic polymers will be critical in determining the future position of cellulose as a chemical raw material. Currently, approximately 85% of the United States chemical cellulose consumption is in these industries. The processes used in these industries provide considerable latitude in manufacturing fibers and films having a wide range of properties. This fact has accounted for the rapid and sustained growth as is illustrated by the recent development of rayon for automotive tires and the earlier development of moistureproof cellophane.

To date, the pulp industry has concentrated primarily on improved pulp refining methods leading to higher alpha pulps of improved color at an acceptable level of reactivity and price. This will not be sufficient for the future. The pulp manufacturers must look upon themselves as polymer manufacturers in strong competition with a dynamic synthetic polymer technology which is based on fundamental studies of the chemistry and physics of the processes and intimate knowledge of the effect of polymer structure on the final product. A broad fundamental study of pulping technology is urgently needed to hold and expand the volume of chemical cellulose against the low-cost "tailor-made" products which will inevitably stem from the rapidly expanding field of basic research on synthetic polymers.

Continuing the program Dr. Emil Heuser discussed "Trends in Fundamental Research in the Cellulose and Wood Pulp Fields" and pointed out the preferred subjects on which fundamental research is carried out and the results that have been obtained concerning cellulose in general and certain phases of wood pulp technology. In the field of fundamental research on cellulose, the desire to clarify the submicroscopic structure of the fiber is unabated, and much progress has been made in the elucidation of its fibrillar structure by making use of new techniques in the field of

(continued on page 64 A)

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electronmicroscopy. These results show that the gap between what the light microscope reveals to the eye and what x ray analysis allows us to deduct is becoming narrower all the time. Of similar interest as the elucidation of the fibrillar nature of the fiber is the ratio of the amorphous to the crystalline portions which varies with the type of fiber or, having more practical purposes in mind, the "accessibility" of the various fibers to reagents. Much work has been done in recent years to perfect the methods for determining this important property of the fiber and to narrow down, as much as possible, the discrepancies between results obtained with different methods. Next to be considered is the molecular weight of cellulose, that is, its average chain length, as it exists in the original plant and, further, its chain-length distribution and how these characteristics change when the cellulose fiber is isolated from the plants and purified to suit present-day technological requirements. Much other research, which likewise concerns the molecular structure, centers around the question of the presence or absence of weaker bonds, that is, other than the common β-1,4-glycosidic linkages which hold the single anhydroglucose units together. Such weaker bonds may be distributed either along the chains or, laterally, between them. In this connection, the interest in the introduction of (synthetic) cross linkages into cellulose continues in various directions. Finally, a new, most promising field of fundamental cellulose research, namely the labeling of atoms of the cellulose molecule by the use of radioactive elements, seems just to have opened its gates. The new tool will be useful in the attempts to elucidate the mechanisms which are operative when cellulose is produced in the plant and when it is subjected to chemical reactions.

Turning to wood pulp, the dividing line between fundamental and applied research is not sharp. The importance of chain length and chain-length distribution as a useful means of learning more about the inner nature of wood pulp is being given increasing attention. In addition, it would seem that a great deal of the interest of the research workers in the pulp field centers around the necessity of having better methods for predicting how a given pulp will behave when put to actual use. Most of the work on pulps for conversion concerns their behavior in the viscose rayon (and cellophane) processes, with particular interest in the filtering properties of the viscose and in the factors which influence this important property. Besides, the improvement of methods which permit to predict the behavior of the pulp during acetylation has had considerable attention. It would seem that some of the results, obtained by applying these new suitability tests to a great variety of pulps, have, in their turn, given a new impetus to the attempts to use, for conversion, besides sulphite also sulphate, as well as certain hardwood pulps. Not much new research has been done on the mechanisms of the sulphite and sulphate cooking processes although some excellent summaries have been presented. These furnish much food for thought and show where much needed knowledge is still lacking. On the other hand, the painstaking and patient research of many years directed to the solution of certain highly important technical problems of pulp manufacture, including the bleaching and purification steps, has been rewarded with success. Finally, the old problem of continuous cooking has found new interest, and some practical results are being achieved.

To complete the program, education was the subject of a talk by John G. Strange of The Institute of Paper Chemistry. In his paper, "Education and the Paper Industry," Mr. Strange discussed education from the standpoints—for what, for whom, and by whom. Education is one of the largest national industries; the net investment in higher education alone in 1947 was approximately $5,000,000,000 as compared with a new worth of $2,870,000,000 for the pulp and paper industry. The burden placed on the educational system by the increases in population and the decreased value of the dollar was considered, together with the recommendations of the Commission appointed by the President in 1946 which involve an extensive Federal aid program. The importance of education to the pulp and paper industry was stressed and the role of the industry in the general program was pointed out. Mr. Strange described the educational aspects of The Institute of Paper Chemistry and mentioned that the most important problem facing the Institute is the selection of the fifteen students which make up the first-year class.

Meeting Program Committee

The success of any program is due to the efforts of those who are involved in its preparation and who conduct it. That this meeting was such a success is because of the intensive efforts of the committee assembled by the Pacific Section of TAPPI and to the managements of the companies in the area which have so sincerely backed the entire program. The participation of those who prepared and conducted the meeting and the various authors is due proof of the degree of company cooperation and the hospitality of the pulp and paper companies of the West Coast in inviting the group mill visits was very much appreciated by those who attended this Fall meeting.

R. J. LeRoux, Weyerhaeuser Timber Co., and A. G. Natwich, Crown Zellerbach Corp. as General Co-Chairmen were assisted by various committees.

The Technical Program Committee with W. F. Holzer, Crown Zellerbach Corp. as chairman and H. W. Bialkowsky, Weyerhaeuser Timber Co.; J. L. McCarthy, University of Washington; B. E. Natwick, Appleton Wire Works Inc.; R. M. True, General Dyestuff Corp.; R. I. Thieme, Sound View Pulp Co.; O. H. Sangder, Rayonier, Inc.; E. O. Ericsson, Puget Sound Pulp & Paper Co.; H. F. Lewis, The Institute of Paper Chemistry; and H. C. Wall, Longview Fibre Co., was responsible for preparing the excellent technical program.

Finances were under the supervision of A. G. Natwick, R. J. LeRoux, and R. M. True, and the extensive publicity given to the 1949 Fall Meeting was due to the efforts of H. H. Richmond, Electric Steel Foundry Co.; Z. A. Wise, Griffith Rubber Mills; and L. K. Smith, Miller Freeman Publications.

M. J. Maguire, Hercules Powder Co., and B. E. Natwick made the hotel arrangements while R. S. Wertheimer, Longview Fibre Co., John Fulton, and J. A. Foxgrover took care of the transportation.

The dancing and entertainment in the evenings was arranged by Ray Smythe, Equipment Sales Agent, and his committee.

The woods trip was the responsibility of H. W. Morgan of the Weyerhaeuser Timber Co.

The Reception Committee was composed of H. D. Des Marais, General Dyestuff Corp., J. W. Hemphill, Johns-Manville Sales Corp. and Z. A. Wise.

Arrangements for the mill visits were made by Ray Baker, Weyerhaeuser Timber Co.; C. A. Enghouse, Crown Zellerbach Corp.; Carl Fahlstrom, Longview Fiber Co.; Gus Ostenson and Fred Weleber, Publishers' Paper Co.

An interesting program was prepared for the ladies, under the direction of Mrs. R. J. LeRoux, Mrs. F. M. Shanaman, Mrs. J. P. Rubush, Mrs. W. H. Williamson, Mrs. W. C. Marshall, Mrs. D. J. Keating and Mrs. J. M. Wilcox. The program included teas, golf, fashion show and a trip to Timberline Lodge on Mt. Hood.

These and many others of the Pacific Section are to be thanked and congratulated for their efforts in conducting this Fall Meeting of the Association.

FOR CORROSION-PROOF CONSTRUCTION...

look to Atlas

ATLAS Chemical Construction Materials have been standard in the pulp and paper industry for many years.

ATLAS service: Engineering—Technical Service—Development and Research are ready to serve the pulp and paper industry.

ATLAS engineers are prepared to investigate your corrosion problems and to make unbiased recommendations. No obligation, of course.

REMEMBER THESE NAMES:

ALKOR Alkali & Acid-proof Cement — KOREZ (R) Acid-proof Cement
REWBON Seamless Rubber Linings — NEOBON Seamless Synthetic Rubber Linings — ZEROK Protective Coatings — ATLASTISEAL Triple Membrane

THE ATLAS MINERAL PRODUCTS COMPANY

MERTZTOWN, PENNA. HOUSTON, TEXAS

1950 Fundamental Research Meeting

Harry F. Lewis, Chairman of the TAPPI Fundamental Research Committee has announced that his committee, in cooperation with the Wood Chemistry Committee of the C.P.P.A. Technical Section will hold a two-day meeting on May 29–30, 1950 at the Chateau Frontenac, Quebec, P. Q., immediately prior to the summer meeting of the C.P.P.A. Technical Section.

The theme of the meeting will be "The Papermaking Properties of Fibers." The plan of the program is to lay out in skeleton form all of the properties of fibers that are believed to be related to papermaking characteristics. These would include such items as the measurement of surface, the nature of fiber to fiber bonding, the methods of measuring bonded areas in the sheet, relation between fiber structure and their properties, such as x ray orientation, measurement of crystalline and amorphous cellulose in the fiber, and the relation of this measurement to the properties of a sheet.

At the previous conferences of the committee the chemical components of the fibers were discussed. There will probably be some consideration given to the significance of the chemical components measured against the papermaking properties.

As a result of this meeting it should be possible to determine what is known and to indicate what is not known about the papermaking properties of the fibers.

Alkaline Pulp Literature Review

The Southern Pulp and Paper Manufacturer has again kindly agreed to finance the preparation of an annotated bibliography and review of the technical literature relating to the alkaline pulping process. This work is being carried out at the Institute of Paper Chemistry on behalf of the TAPPI Alkaline Pulping Committee, Henry J. Vranian, The Chesapeake Corp., Chairman. A previous report was published in the June issue of *Tappi*. *The Southern Pulp and Paper Manufacturer* and its Editor, Vincent J. Waters, are members of the Technical Association. This type of service represents good industry citizenship on the part of the Southern magazine.

Engineering Conference Trip

Following the Fourth Engineering Conference to be held at Boston (October 31–November 3), there will be visits to the machinery plants serving the industry in the Lynn, E. Walpole, Hyde Park, and Worcester areas.

Charles Sumner Barton, President of the Rice Barton Corp., has supplied information with particular reference to the Worcester trip on November 3rd. Transportation will be furnished and present plans call for a visit to the Riley Stoker Corp. plant in the morning where motion pictures will be shown of the latest developments in steam generating equipment. Luncheon will be served at the Norton Co., plant where the manufacture of pulp stones will be shown.

In the afternoon the group will visit the plants of the Rice Barton Corp., and the Lodding Engineering Co., after which refreshments will be served at the Worcester Club. Buses will return the group to the Statler Hotel in Boston.

Error in August Tappi

Dan Patch of Morton C. Tuttle Co., Boston, Mass., reads *Tappi* and advises us that on page 62 A of the August issue, in the right hand column about two-thirds of the way down the page W = moisture as percentage of green weight. (The W should be M).

EMPLOYMENT SERVICE

Letters in reference to employment should be sent to the Box number mentioned below c/o Tappi, 122 East 42nd Street, New York 17, N. Y.

POSITIONS OPEN

P30-49. Superintendent: Wood and rag preparation in manufacturing of roofing felt paper on cylinder machines. Asbestos paper experience desirable. Age mid-forties.

P32-49. Chemist or chemical engineer for research and development on wall paper. Previous experience in paper coating desirable.

P33-49. Instrumentation engineer. Well-established firm needs services of graduate engineer, experienced in paper and pulp instrumentation. Position involves product development and sales engineering. Requires traveling 40% of time. Compensation plan is attractive and gives full recognition to individual effort.

P34-49. Development chemist in field of latex impregnated paper. New England.

P35-49. Young chemist. 2–3 years' experience in treatment of paper preferred. Process and trouble shooting. Good opportunity with paper tube manufacturer in Washington, D. C.

POSITIONS WANTED

E43-49. Chemist. 5 years' experience paper conversion on containers and closures. 4 years' experience organic chemistry and teaching. Knowledge of adhesives, coatings, resins, lacquers. Desires position in research or plant control.

E34-49. Chemist. Paper technologist, with engineering experience. 33. B.A. chemistry, 10 years' research and 3 years industrial experience including quality control and statistical analysis. Considerable pulping and bleaching exp. Some exp. adhesives and coatings.

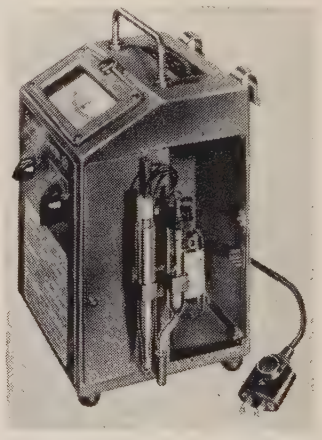
E44-49. Chemical Engineer, 38. Experienced as technical superintendent in kraft, sulphite, news, and specialties. Desires position in Midwest or Northeastern States.

THE

CAMBRIDGE

INDUSTRIAL MODEL
DIRECT READING

pH METER

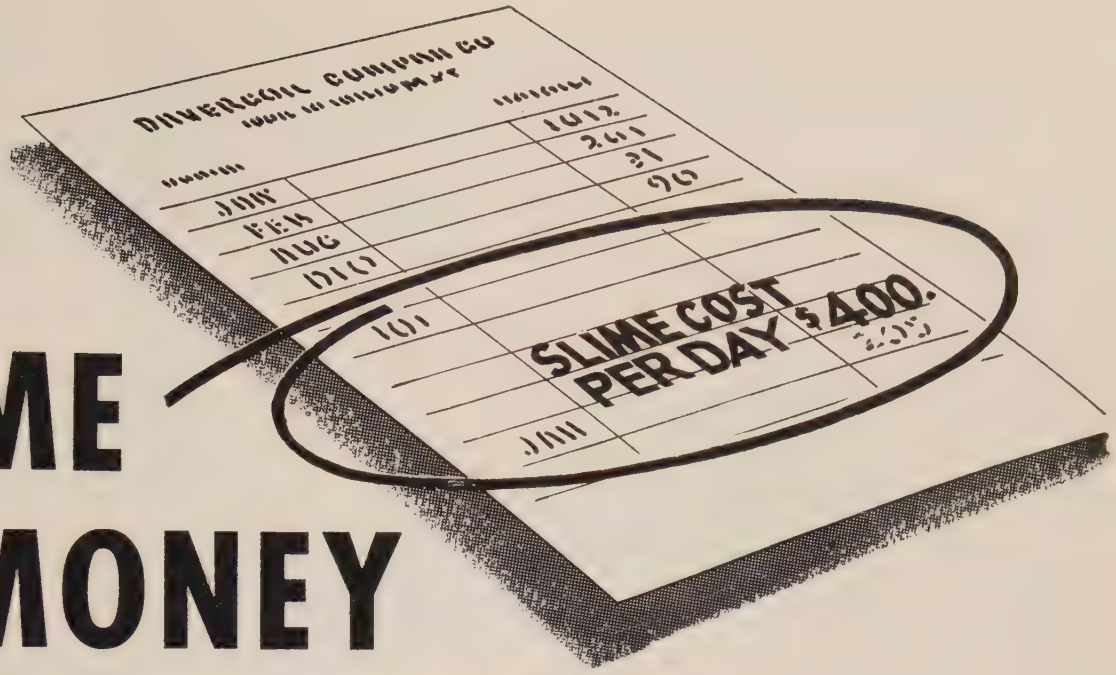


- Operates from any AC outlet.
- Completely portable. Electrodes are integral parts of the instrument.
- Accurate to .10 pH.
- Shielded glass electrodes permit use of electrodes at any distance from the instrument.
- May be used on a bench or wall-mounted.
- Self contained in one metal case including electrodes and buffer solution.
- Extremely stable.
- Automatic temperature compensation.

Send for Bulletin 910-NA

Also available: Electron-Ray Research Model accurate to .02 pH and Laboratory model accurate to .05 pH and Single- and Multi-point recorders.

CAMBRIDGE INSTRUMENT CO., INC.
3775 GRAND CENTRAL TERMINAL NEW YORK 17, N. Y.
Pioneer Manufacturers of
PRECISION INSTRUMENTS

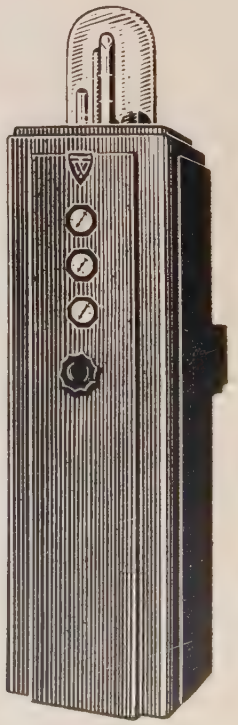


SLIME IS MONEY

Although you may never see a bill, studies show that slime costs the average paper mill $400 or more a day and is responsible for such costly troubles as wet end breaks, pin holes, slime spots, poor sheet formation, etc.

Break-Point Chlorination, engineered to your particular needs, has proven its slime fighting ability in hundreds of installations. This process, applied by dependable W&T Chlorinators, to your fresh water supply, often in conjunction with chloramines or other corrective chemicals to your stock or white water, gets results because it destroys the very cause of the trouble — slime forming bacteria. Moreover, members of W&T's nation-wide service organization with over 35 years' experience at their fingertips, carefully engineer each installation, to insure that you will receive maximum protection against slime at the lowest possible cost.

Your nearest W&T Representative will be glad to give you full details on how Break-Point Chlorination can cut your slime costs. Call him today.



WALLACE & TIERNAN
COMPANY, INC.
CHLORINE AND CHEMICAL CONTROL EQUIPMENT
NEWARK 1, NEW JERSEY • REPRESENTED IN PRINCIPAL CITIES

I-28

PERSONAL MENTION

Items About New and Old Tappimen

New TAPPI Members

Ralph H. Ball, Manager, Cellulose Div., Celanese Corporation of America, New York, N. Y., a 1931 graduate of McGill University with a Ph.D. degree.

Robert D. Batten, Sales Representative, Minnesota and Ontario Paper Co., Chicago, Ill.

George E. Clink, Assistant Supervisor of Engineering, The Sandy Hill Iron & Brass Works, Hudson Falls, N. Y., a 1929 graduate of Cornell University.

Robert Essex, Chemist, The McBee Co., Athens, Ohio, a 1934 graduate of Ohio University with an M.A. degree in 1940.

Julio Frank, Superintendent, Fabrica Nacional de Papel, S.A., Montevideo, Uruguay, a 1933 graduate of Technology College, Kothen, Germany.

I. J. Gruntfest, Head of Paper Laboratory, Rohm and Haas Co., Philadelphia, Pa., a 1941 graduate of Cornell University with a Ph.D. degree.

James C. Hair, Production Manager, Crossett Paper Mills, Crossett, Ark., a 1928 graduate of Clemson A & M College.

Alberto Lenz, Jr., Director, Fabricas de Papel Loreto y Pena Pobre, S.A., Villa Obregon, D.F. Mexico.

John Metcalfe, Principal Librarian and Secretary, Public Library of New South Wales, Sydney, Australia.

R. David Ragle, Student, Colorado University, Boulder, Col.

J. P. Rasteiro, Managing Director, Fabrica de Papel de Matrena, Lisbon, Portugal.

James L. Ritchie, Executive Director, United States Pulp Producers Association, New York, N. Y., a 1928 graduate of Williams College.

Samuel J. Robinson, General Manager, Publishers' Paper Co., Oregon City, Ore., a 1934 graduate of Institute of Paper Chemistry with a Ph.D. degree.

Jose Louis Schaan, Technical Manager, Nordling Mace and Cy, Paris, France, a 1943 graduate of Grenoble University.

Rudolf Sieber, Technical Director, Zellstofffabrik Waldhof, Wiesbaden, Germany, a 1914 graduate of Technical High School, Darmstadt, with a Ph.D. degree.

Ferne E. Simpson, Librarian, A. E. Staley Mfg. Co., Decatur, Ill., a 1943 graduate of Central State College, Edmond, Okla.

John K. Sullins, Chemical Engineer, The Mead Corporation, Chillicothe, Ohio, a 1948 graduate of the University of Tennessee.

Frans V. E. Vaurio, Research Assistant, Institute of Paper Chemistry, Appleton, Wis., a 1932 graduate of Northwestern University, with an M.S. degree from the University of Minnesota in 1939.

Charles E. Young, Chemical Engineer, Crown Zellerbach Corp., West Linn, Ore., a 1948 graduate of the University of Colorado.

Tappi Notes

Owen C. Abbott, application engineer of the Bristol Co., has been transferred from Atlanta to Detroit.

Oliver Axtel, formerly instructor of the University of Maine, is now a student at the Massachusetts Institute of Technology.

A. W. Ayles, formerly of the American Cyanamid Co., is now in the Sales Service Department of Penick & Ford, Ltd., Inc., Cloquet, Minn

Hans Baars, formerly with Van Gelder Zonen in Holland is now in the Technical Department, Celdecor Africa (Pty) Ltd., Benoni, Transvaal, South Africa.

Richard L. Betts, chemist for the Champion Paper & Fibre Co., has been transferred from Hamilton, Ohio, to Pasadena, Texas.

Maurice Brot of Richmond, Va., and former Professor of Pulp and Paper at Grenoble University is now in Algiers, North Africa, making a study of esparto for papermaking.

Vance P. Edwardes has retired as Sulphite Superintendent for the International Paper Co., and is now a Consultant at Corinth, N. Y.

William Elsevier is now research chemist for the Southern Kraft Division at Mobile, Ala.

Raymond E. Green, Electrical Engineer for the Rao Electrical Equipment Co., has been transferred from Atlanta to 150 E. 41st Street, New York, N. Y.

Ward D. Harrison is now Vice-President in charge of Production for the Riegel Paper Corp., Milford, N. J.

Frank J. Lovegren of W. C. Hamilton & Sons, Miquon, Pa., has been transferred from the Technical Department to the Production Department where he is Stock Preparation Supervisor.

W. P. Lawrence of the Champion Paper & Fibre Co., has been transferred from Canton, N. C., to Hamilton, Ohio, where he is Assistant Director of General Research.

Ernest C. Manders, formerly of Long Lac Pulp and Paper Co., is now Technical Superintendent of the Coosa River Newsprint Co., Coosa Pines, Ala.

William C. Martin, formerly of the Institute of Paper Chemistry is now Chief Paper Chemist, Moraine Paper Co., W. Carrollton, Ohio.

James H. McClure, formerly of the St. Regis Paper Co., is now Consulting Engineer, 157 Academy St., Watertown, N. Y.

Melvin L. McCreary of the West Virginia Pulp and Paper Co., has been transferred from Williamsburg, Pa., where he was manager to the Sales Dept. in New York City.

Raymond P. McGinley, formerly of the Dilts Machine Works is now Technical Director, Missisquoi Corp., Sheldon Springs, Vt.

Merrill R. Morrison of the Pulp Div., Weyerhaeuser Timber Co., has been transferred from Longview, Wash., to Springfield, Ore., where he is Shift Superintendent.

L. V. Subba Rao who has been with the Sandy Hill Iron & Brass Works is now at the University of Alabama.

Robert G. Ruark of the Corn Products Refining Co., has been transferred from the Mellon Institute in Pittsburgh to Argo, Ill., where he is Assistant to the General Manager.

Alfred L. Saindon, Jr., formerly of the University of Maine, is now Chemist for the Curtis Paper Co., Newark, Del.

Gilbert Stevens, Asst. Director of Research has been transferred to the Paper Sales Div., Minnesota & Ontario Paper Co., Minneapolis, Minn.

H. Van der Raay, formerly of the South African Pulp and Paper Industries, Ltd., is now Chief Engineer, Celdecor Africa, Ltd., Benoni, Transvaal, South Africa.

Lawrence W. Whitaker, formerly of Stein, Hall & Co., is now a Manufacturers Agent, representing Junkung Bros., and P. Q. Moore Co., Inc., 127 Laurel Drive, New Hyde Park, N. Y.

(continued on page 70 A)

UNION

The Trade Name for Top Quality

SCREEN PLATES

MEET THE EXACTING DEMANDS OF CANADIAN PULP AND PAPER MILLS

The quality and dependability of UNION Screen Plates are backed by over forty years' experience in satisfying the needs of Canadian pulp and paper mills.

GIVE MAXIMUM PERFORMANCE UNDER ALL CONDITIONS

UNION Screen Plates are made in our own foundry to our own special formula, using the best materials available. Our laboratory-trained experts control all operations, thus ensuring the utmost satisfaction and value in service.

ALL STYLES AND TYPES AVAILABLE

UNION can supply Screen Plates in any style of cut or number of slots per inch; Chromium Plated, Stainless Steel, Cast Bronze, Phosphor Bronze, Inconel and Rolled Copper. Special Plates also made to order.

UNION also manufactures a complete line of Screen Plate accessories.

UNION SCREEN PLATE COMPANY OF CANADA LIMITED

Head Office and Plant: Lennoxville, Que. Sales Offices: Montreal and Toronto.

(continued from page 68 A)

* * *

J. E. Hartford, formerly Production Manager of The Philip Carey Mfg. Co., has joined the Black-Clawson sales staff at Hamilton, Ohio. Mr. Hartford is a graduate chemical engineer from Iowa State College, 1933.

* * *

Spencer W. Pitts has been elected Secretary of the J. M. Huber Co., New York, N. Y.

* * *

Charles S. Booth has succeeded Sir Herbert Gepp as official corporate representative of the *Australian Paper Mfgrs. Ltd.*, South Melbourne, Australia, in TAPPI.

C. William Converse has succeeded Frank C. Vaughan as official representative of *Sprout, Waldron & Co.*, Muncy, Pa., in TAPPI.

L. P. Stewart has succeeded N. R. Gotthoffer as official representative of *The Drackett Company*, Cincinnati, Ohio, in TAPPI.

* * *

Recent overseas visitors to the United States were:

J. Claus, Director of the Packaging Experimental Station, National Council for Industrial Research, Delft, Holland.

R. F. Mailaender, Factory Manager, Orient Paper Mills, Ltd., Calcutta, India.

* * *

Hilmar B. Moen, Production Superintendent, Whakatane Board Mills, Ltd., Whakatane, New Zealand, is now visiting in the United States.

Gunnar Segerstrom, Engineer at Nordstroms Linbanor, Stockholm, Sweden, is visiting in the United States.

* * *

The following companies recently have become corporate members of the Technical Association:

Brownville Paper Co., Brownville, N. Y.
Cartiere Giacomo Bosso, Vorino, Italy
General Waxed Papers Co., Chicago, Ill.

* * *

The following companies recently became sustaining members of the Technical Association:

Atlas Mineral Products Co., Mertztown, Pa.
California Research Corp., San Francisco, Calif.
Chiksan Co., Brea, Calif.
Frank W. Egan & Co., Bound Brook, N. J.

* * *

Joseph Constance, Plant Manager of the Millers Falls Paper Co., Millers Falls, Mass., has succeeded John L. Bagg (retired) as official representative of his Company in TAPPI.

Industrial Notes

John M. Huber Corp., has appointed Edward J. Lewis Co., 9 S. Clinton St., Chicago, Ill., as its representative in the Chicago area for carbon blacks, clays, and rubber chemicals.

* * *

The Atlas Mineral Products Co. Research Laboratories at Mertztown, Pa., were dedicated on August 20 as a memorial to the late Maximillian F. Wirtz who founded the firm in 1892. The new laboratories are housed in a 2-story brick building with over 5000 sq. ft. of floor space. The Atlas Laboratories are staffed by twelve chemists under the direction of Raymond B. Seymour, Technical Director, and Joseph Dahl, Research Director. The laboratories are equipped for the investigation of problems related to corrosion resistant materials. A research project on the fundamental investigation of sulphur compound pipe joints is under way at Lehigh University. The Atlas Mineral Products Co., who is a member of TAPPI was one of the first manufacturers of phenolic acid-proof cements, and polyvinyl chloride based coatings.

Part of the Staff of the Atlas Laboratories—front row, left to right: George Gabriel; Joseph Dahle, Director of Research; James Fry. Second row: Carl DeLong; Willard Lantz; Walter Pascoe; William Rutter; Clifford Reinert; Richard Merkel; and Carl Romig. Dr. Raymond B. Seymour, Technical Director, and Earl Erich were absent

* * *

The Chiksan Co. Brea, Calif., has just issued bulletins on its ball bearing high temperature rotating and swivel joints.

* * *

The Dorr Co., will move its main office from New York City to Northam Warren Bldg., on Barry Place, Stamford, Conn., in December.

* * *

Harold Harvey of Penick & Ford, Ltd., is now Sales Manager for the Company on the West Coast with headquarters in San Francisco, Calif. S. F. M. Maclaren will succeed Mr. Harvey as Divisional Sales Manager for Ohio, Pennsylvania, and Western New York.

* * *

R. J. Jacobs and L. E. De Weese have recently become field representatives for the Dilts Div., Black-Clawson Co. to handle Dilts converting equipment. Mr. De Weese was Vice-President of the Kohler System Co., now owned by The Black-Clawson Co.

* * *

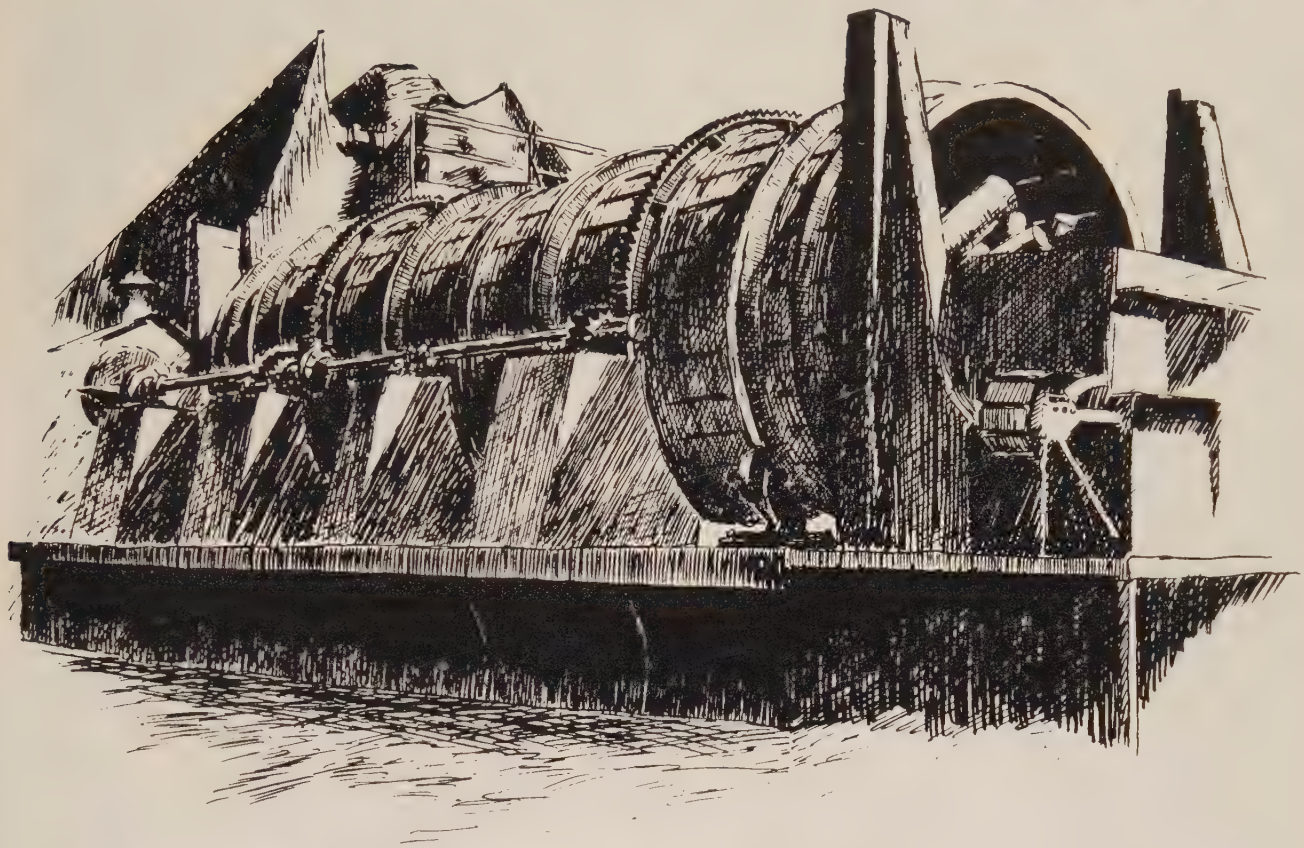
Pillsbury Mills, Inc., is now marketing "Capsuled" industrial enzymes for the conversion of starch used for coating paper. On this new division, J. Thomas Haigh heads the Technical Service Laboratory in Minneapolis. Rowland A. Gale in New York directs the field service. Burton F. Bowman is Director of Pillsbury's Industrial Products Division, Pillsbury Bldg., Minneapolis 2, Minn.

* * *

James Deshler II, President of Edgar Brothers Co.,

(continued on page 72 A)

NEWPORT NEWS
WELDED LOG BARKER



Sturdy Construction . . . Rugged Performance

THE Newport News 45-foot welded log barker consists of two slotted drum sections with a total weight of 148,000 pounds. Each section is fabricated from three 1¼ inch steel plate rings welded together in halves. Heavy circumferential stiffener rings are welded on the outside of each section. The barker is equipped with cast steel gears and forged steel rails. After assembly and welding, each section is completely stress relieved.

The rugged performance record of the Newport News barker has proven the soundness of its sturdy one piece construction. Write for additional details.

NEWPORT NEWS
SHIPBUILDING AND DRY DOCK CO.
NEWPORT NEWS, VIRGINIA

(continued from page 70 A)

Metuchen, N. J., has announced that the voting control of the Company has passed to its employees under a plan made possible through the generosity of the Edgar family. All the large common stockholders either sold their stock to employees or exchanged it for preferred stock. No change in current Company policies or operations is expected. Edgar Brothers Co., is celebrating its 50th Anniversary this year. The Company pioneered in the introduction of domestic clays to the paper trade. Today filler and coating clays for paper are the Company's chief products. Two mines and six plants for water-washing of clays are located at McIntyre, and Gardner, Ga.

* * *

Approximately a hundred engineers and executives visited the plants of the Lukens Steel Co. and its divisions, the By-Products Steel Co. and Lukenweld, as guests of Robert W. Wolcott, President of the company, on September 1, 1949.

Lukens was the pioneer in clad steel manufacture and now produces the widest range of these materials obtainable anywhere in the world. These materials are used in the pulp and paper chemical fields for corrosion resistant equipment to protect pulp and paper and chemicals during processing and handling. The visit included the nickel-plating plant which prepares the "inserts" of stainless steel and Inconel for bonding to the backing plates of carbon steel, thus assuring a permanent bond.

The Lukens sodium hydride plant for descaling and pickling clad steel plates and heads was also an important part of the trip. This is the largest and most intensive plant of its kind with facilities for descaling plates up to 456 inches long. This method imparts a finish which is far superior to the surface produced by grit or sand blasting.

At Lukenweld, the fabricating division, jacketed drier roll manufacture was viewed in progressive stages of fabrication, first the inner steel plate shell with its orifices for steam entry through the spokes, then the outer steel plate shell, and finally the machined assembly ready for installation. Lukenweld was the first commercial weldery in the United States specializing in designing, engineering, and fabricating welded steel structures.

The Lukens Steel Co. has installed the world's largest plate mill where plates up to 195 inches wide are regularly produced. Wide plates have resulted in the economical fabrication of large and heavy equipment including some of the largest stills, tanks, and towers now in use. Such equipment also utilizes heads spun on spinning machines, and the biggest unit, which is the largest flanging machine ever built, can produce heads up to 246 inches in diameter.

The tour was concluded by seeing the open-hearth furnaces, and a plant of the By-Products Steel Co. Division, which has the equipment to press, bend, shear, and blank steel plate shapes for rings, shells, bent sections, and pressings.

* * *

Ray A. Walker, publisher of *Recommendations*, a magazine for motor courts and resorts, Haverhill, Mass., wishes to obtain sanitary, single-use bath mats. The size should be from $13^2/_3 \times 21^3/_4$ inches to 15 × 24 inches and cost no more than one cent a sheet in carload quantities. It must be absorbent yet resistant to disintegration in water, and should have a surface suitable for printing. The color should be fairly light. Samples should be sent to Mr. Walker. (*Ed. Note.* This looks like another substitution of paper for textiles.)

Edward J. Johnstone

Edward J. Johnstone, Sales Engineer for the Lockport Felt Co., Newfane, N. Y., for the past eighteen years died on August 30. Mr. Johnstone was born at Antwerp, N. Y., on January 14, 1888 and was a graduate of chemical engineering of the Pratt Institute in Brooklyn in 1908. From 1908 to 1917 he was associated with Professor F. M. Williams as a pulp and paper consultant at Watertown, N. Y. During the First World War he served as a Lieutenant in the Navy. Following this period he was Chief of the Testing Bureau, Mattagami Pulp and Paper Co., Smooth Rock Falls, Ont. From 1920–1922 he was General Manager of the Williams Apparatus Co., in Watertown. In 1922 he joined the technical staff of the Paper Makers Chemical Co., in Holyoke. When that Company became part of the Hercules Powder Co., he became associated with the Lockport Felt Co., as a sales engineer. He was a member of the Technical Association of the Pulp and Paper Industry since 1920.

One of the Men behind Eastwood Wires

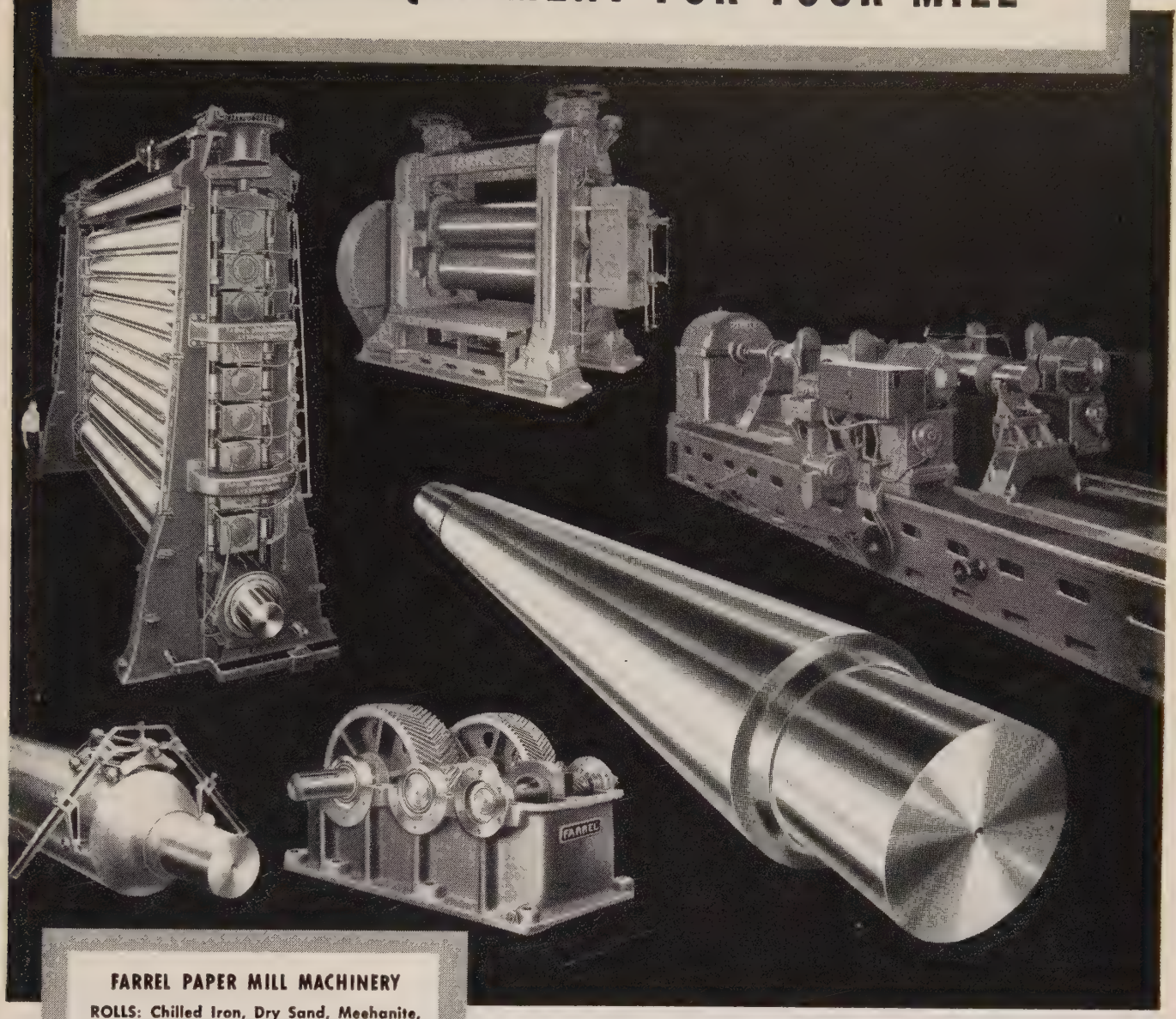
James Dorney

Whose work is always "on the beam"

The spools of wire you see in the background are being wound onto the back beam of a loom. Every single wire from the 60 or more spools (depending on the size of the mesh) must be guided into an exact place of its own on the beam. Only a one-inch section of the beam can be filled at a time. After this back beam is filled, each warp wire must be threaded through guides leading to the front of the loom, where the actual weaving takes place. This is one more of the many painstaking operations in the manufacture of quality fourdrinier wires.

EASTWOOD-NEALLEY CORPORATION • Belleville, N. J.

FARREL EQUIPMENT FOR YOUR MILL



FARREL PAPER MILL MACHINERY

ROLLS: Chilled Iron, Dry Sand, Meehanite, Alloy Iron, Steel, Chromium Plated

FOR: Calender Stacks
Board Calenders
Super Calenders
Glassine Calenders
Friction Rolls
Breaker Rolls
Smoothing Rolls
Coating Rolls
Creping Rolls
Plater Rolls
Cutting Rolls
Paraffining and Waxing Rolls
Saturating Rolls
Silicating Rolls
Miscellaneous Special Purposes

CALENDERS: Paper and Board
GRINDING MACHINES: Roll
CALIPERS: Roll
GEARS, CUT: Spur, Single and Double Helical (Farrel-Sykes Continuous Tooth Type)
SPEED REDUCING GEAR UNITS
SPEED INCREASING GEAR UNITS
FLEXIBLE COUPLINGS

The next time you need precise, long-lived rolls, a *designed-for-the-job* calender, a precision roll grinder, a caliper for quick and accurate roll checking, a quiet and efficient speed reducer, or any of the other equipment listed here, call Farrel. This equipment is made by a company that has been working for the paper industry for nearly a century, and knows its most exacting requirements.

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Local Sections in a Professional Society*

R. G. MACDONALD

When your Convention Committee asked me to prepare some remarks for presentation at the opening session of the 1949 fall meeting of the Technical Association it immediately occurred to me that any comments that would be appropriate would need to deal largely with one important aspect of this meeting namely, the part being played by a local section in serving the entire Association as the Pacific Section is doing on this occasion.

This is the third time since 1929 that the Pacific Section has undertaken this important service. Although its first effort was made in 1934 I refer specifically to 1929 since that is the year that the Pacific Section was formed. It was my privilege to be present at the meeting held in the New Washington Hotel in Seattle when this Section became established and elected its first officers.

During the previous year I devoted some time in going up and down the Coast from British Columbia to Southern California to sound out the desire for such an organization. There had been an effort made in 1927 and 1928 to form another association similar to TAPPI but this plan had been rejected by the management of the mills. Following this attempt, the promotors of the independent association asked our Executive Committee to survey the field and encourage the formation of a TAPPI local section.

Until 1929 there had been no local section formed that had survived. At the organization meeting I pointed out that one of the important requirements of any local section would be its ability to survive. Such a necessity called for local leadership, capable of organizing a group and developing of future leaders.

All of the local sections of the Association that have received charters have survived to date, although in one or two cases there were periods of a year or two when good leadership in some regions was at a low ebb. However, because such groups were definitely parts of the national Association, new leadership arose and which, often taking a new tack, revived its organizations. In some cases the reorganized groups were superior to their predecessors.

The Pacific Section has done an excellent job in developing new leaders. It has accomplished this job largely through its encouragement of younger members. The creation of the now famous Shibley Award has been the focal point of this development and the basis for obtaining the much needed support of the regional mill management.

Since other groups have attempted to follow the award procedure but have not continued their efforts we might ask why this situation has existed. To one who has watched the Pacific Section over the years it has become evident that the Shibley Award competition is successful because this Section has had the single-mindedness to make it so. However, even this competition would not have spelled success without the support of the men in the management of the mills. They saw the merit of encouraging their young technical men to do the work necessary in preparing essays that could meet the high and stringent standards that were required by the reviewing board of the Section. What has been said about the merits of the Shibley Award were not intended to dramatize the competition itself but rather to point out a way in which a local section may approach the aim of high grade professional practice.

The seminars conducted by the Pacific Section represent another major effort in attaining professional status. By bringing such outstanding individuals as the Erdtmans, Mark, Graff, Heuser, and others to the lecture platforms in Seattle and Portland the Section made contributions that should have lasting influence on the technology of the industry in the Northwest.

What have these spectacular accomplishments to do with National TAPPI? The local sections are a definite part of the Association structure. To the people located in any pulp and paper manufacturing region the local section of TAPPI is TAPPI itself to them. What the section does, what kind of leadership it has, the type of programs it presents, and the participation of members in those programs tend to reflect to some extent in its mind, the Association.

The local sections are so organized that nearly anyone interested in pulp and paper may become members of these groups. It is not even necessary to be a member of the national organization to join a section. At stated times meetings are held and all who wish to attend are welcome to do so. Who then attends such meetings? Are there mill managers, engineers, superintendent, chemists, and other technical men from the mills, technical men and salesmen from the supply and service industries among those present? The answer is that segments from all of the aforementioned classifications attend meetings and enter into the organization activities of the section only if they consider it personally worth while to do so. Such a situation presents a subject for consideration by the executive and program committees of each section. Whom do they want to join with them? This question of programs poses a problem.

It is not to be expected that any set program of activities will appeal to all of the aforementioned classes, at least in the form in which such programs are often presented. Such programs, however, at least have a broader appeal if the standards are maintained at a high level.

The subject matter itself is not all important. A commonplace subject dealing with the design and operation of a wheel-barrow can be presented and discussed in such a way that listeners can go away with a profitable increase in knowledge. On the other hand, a presentation dealing with the location of a methoxy group in a complex formula can be handled in such a way that one who is not endowed with an education in chemistry can grasp the significance of such a report and have his imagination and interest whetted to the extent of wanting to learn more about the subject. A certain amount of so called "know-how," an intangible that cannot be described in any other way, is necessary to accomplish these objectives.

Thus far we have discussed the professional part of local section meetings, dealing largely with the maintenance of a local organization that is trying to perform a service in harmony with the objectives of the national association. In this connection it should also be remembered that the same problems confront the national organization that are met by local groups. However, I do not intend to compare the national body with its local sections in any way, realizing

(continued on page 76 A)

* An address by R. G. Macdonald, Secretary, Technical Association of the Pulp and Paper Industry at the fall meeting of the Association, Multnomah Hotel, Portland, Ore., Sept. 14, 1949.

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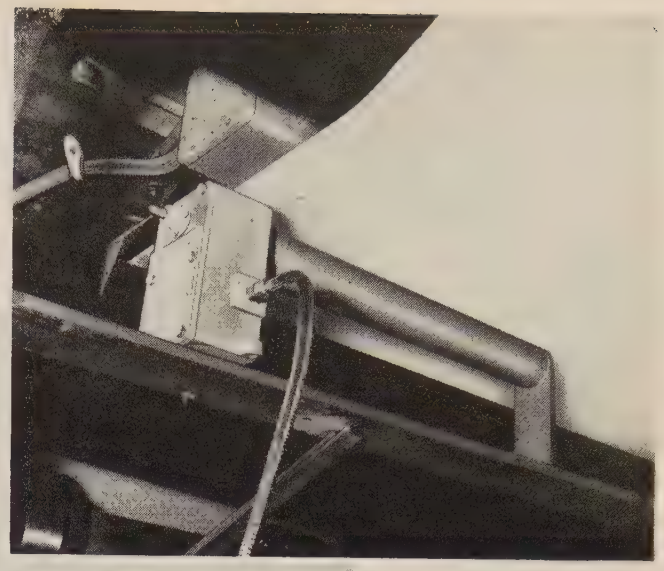

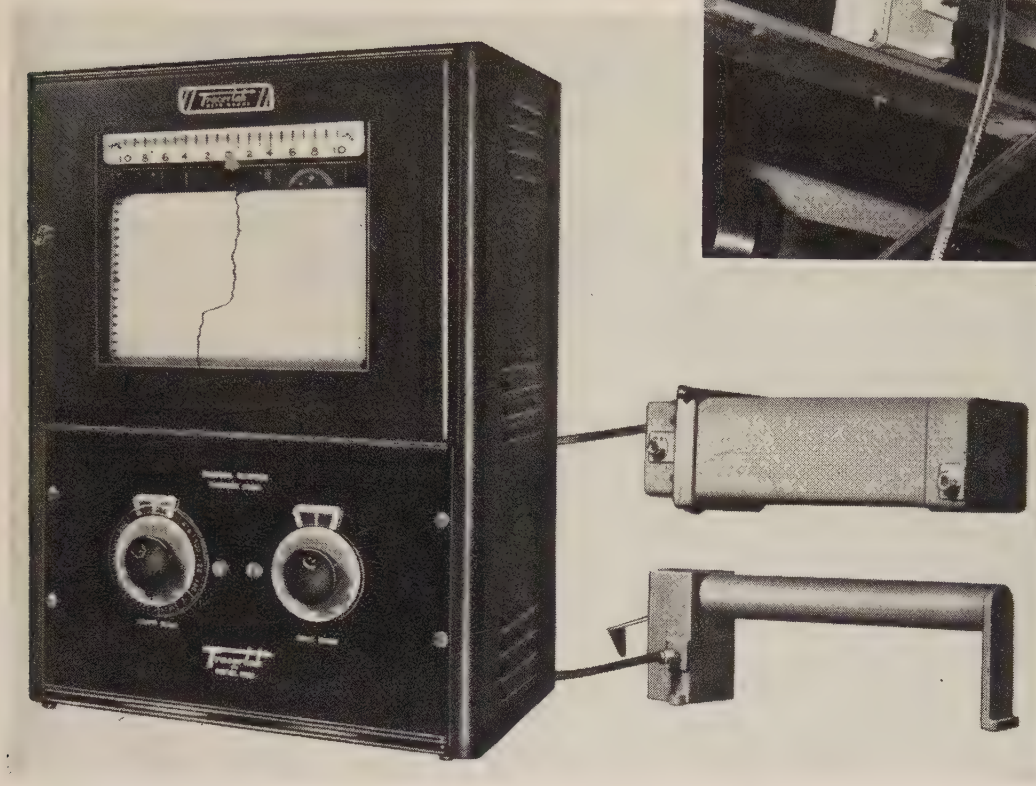

A Tracerlab Beta Gauge installation for measuring paper board at Continental Paper Co., Ridgefield Park, New Jersey.

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(continued from page 74 A)

that the national body can call on the best talent in the industry wherever it may be found. The only point that I should like to make is to indicate that the national body has established a pattern for attaining its ends. The aims of the Association are reflected in its committee and divisional activities as well as in its various publications. Its deficiencies and the reasons for them are best known to the executive committee chairmen. Each year reveals some progress in overcoming these deficiencies, improving the quality of the work of the Association and in doing an educational job for those who are penetrating the frontiers of knowledge, and for those who are doing the daily operating jobs. The benefits of such knowledge are available to juniors, and individuals who are primarily interested in knowing the significance of practical and everyday manufacturing procedures and problems.

It is this committee organization pattern that I hope will gradually be noted by the leaders of our local sections. There is so much to be done that no one can object to any effort made in the fields represented by any of our committees. The only specific request of national TAPPI is that the job be done on a high plane. I purposely do not say "a high technical plane since such a term might sound forbidding. To put the matter in other words the work should be based on careful observations, reliable measurements, and sound interpretations which in a sense is what I mean by "technical." However, a good so-called technical or engineering education is, of course, of tremendous value to carrying out such observations, measurements, and interpretations.

The publications of the Technical Association tend to reflect the organizations activities and emphasis on quality. TAPPI Standards represent the effort of a very large number of our members over many years. A single testing method often requires continuous study for a number of years before the members of the Association will give it official approval. The Data Sheets have not received as much attention but now a special committee in our Engineering Division has been established to review present and future data sheets and to improve their quality. The Bibliographies of Papermaking are prepared annually by one of the leading bibliographers and the Association's magazine *Tappi* is prepared under the supervision of an Editorial Board made up of experts in their respective fields. Each article appearing in the continuously paginated section of the magazine is there because it has met rigid specifications based on originality, facts and logical interpretation of such facts. On this basis the quality of papers presented at national and local section meetings will be reflected by the number that are accepted for publication in this section of the magazine.

To sum up let us say that the Association is endeavoring to attain the standards of a professional society. In its committee organization and publications it has established the means to attain its end. It would like to have its local sections strive in the same direction insofar as they are able to do so in meeting the needs of their members. The Pacific Section has always featured quality in its various activities. The only job that it might give additional thought to is to determine how it can contribute even more to the professional status of the National Association.

Maine-New Hampshire

The Maine-New Hampshire Section of Tappi will hold its Fall meeting at the Lafayette Hotel in Portland, Me., Oct. 21, and 22. The theme of the meeting will be "Chemical Reinforcers as Applied to Papermaking."

Registration will be from 1:30 to 2:30 p.m., Friday afternoon, Oct. 21, after which the following papers will be presented: (1) "Trend in the Pulp and Paper Industry," by W. H. Aiken, Assistant Manager, Chemical Division, Goodyear Tire and Rubber Co.; (2) "Use of Natural and Modified Starches in the Beater," by O. R. Steffens, Penick and Ford, Ltd.; (3) "Manufacturing of Plastic by the Beater Addition Process," by Francis H. Snyder, President of Snyder Chemical Co.; and (4) "Influence of Surface Properties of Fibers on Papermaking," by Edward F. Thode, Assistant Professor of Chemical Engineering, University of Maine. There will be a dinner in the evening.

Saturday morning A. P. Schrieber, Tracer Laboratories, Inc., Boston, Mass. will discuss "Application of Radio Activity Techniques to Papermaking." This paper will be followed by a panel discussion on "Starches and other Beater Additives." It is planned to adjourn the meeting at 11:30 a.m. to give those interested in attending the Bowdoin-Colby football game at Brunswick, and the University of Maine-Bates game at Lewiston, time to get to the games. The starting time of the games is 1:30 p.m. Those attending the football games should procure their own tickets. No tickets will be available at the convention.

The Technical Program Committee consists of George Day Brown Co., Berlin, N. H.; Richard S. French, Keyes Fiber Co., Waterville, Me.; and John B. Calkin, Director of the Department of Industrial Cooperation, University of Maine.

The Local Arrangements Committee consists of Joseph J. Thomas, S. D. Warren Co., Westbrook, Me.; Harold E. Pratt, Pejepscot Paper Co., Brunswick, Me.; and Fred H. Frost, S. D. Warren Co., Westbrook, Me.

Chicago

The Chicago Section met at the Chicago Bar Association rooms on September 19. The speaker was E. M. Paulson of Plastic Printing Plates, Inc., Oak Park, Ill., who talked on "Thermosetting Plastic Printing Plates." Mr. Paulson stated that plastic printing plates, under test, have produced more than 60,000 impressions in letter-press printing. The plates do not burn, nor support combustion. They do not soften change dimensions, chip or dent easily, creep and reproduce with fidelity the finest hair lines and dots of originals. In other words they perform like metal plates.

Empire State

Metropolitan Group

The Metropolitan Group of the Empire State Section met at the Fraunces Tavern, New York City, on September 12. Lewis S. Reid, Vice-Chairman presided. The principal address was given by Harry Specht, Vice-President of Eastwood-Nealley Corp., Belleville, N. J., who reported on his recent trip to Europe, including France, Italy, Switzerland, Luxemburg, Belgium, Holland, England, Scotland, and Ireland. His outstanding impression was the awareness of Europeans to the financial help being given by America. He believed that this help has saved Europe from going communistic.

Northern Group

The Northern Group of the Empire State Section met at Watertown, N. Y., on October 13. Richard T. Trelfa, Hercules Powder Co., Kalamazoo, Mich., was the speaker. He discussed "Practical Aspects of Statistical Control."

Western Group

The Western Group of the Empire State Section visited the plant of the Carborundum Co., in Niagara Falls, N. Y., on the afternoon of October 12. Following this E. D. Lackey, Asst. Director of Industrial Relations of the Carborundum Co., showed a motion picture "Romance of Industry." Following the dinner in the plant cafeteria W.

(continued on page 78 A)

MILL REPORTS

Two years ago the ORR-CHEM felt story "broke." It was explained that by giving standard felts a special chemical treatment on specially designed equipment such felts became better performers than felts not so treated.

Today, with a whole drawer of mill reports to back up those original claims, it is our pleasure to reassert those claims and again urge mills not already using ORR-CHEMS to give them a trial.

1. They set to the machine quicker and better.
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Approximately 40% of the total Orr felt production today gets the special ORR-CHEM treatment prior to shipment. How about a few ORR-CHEMS for you to try?

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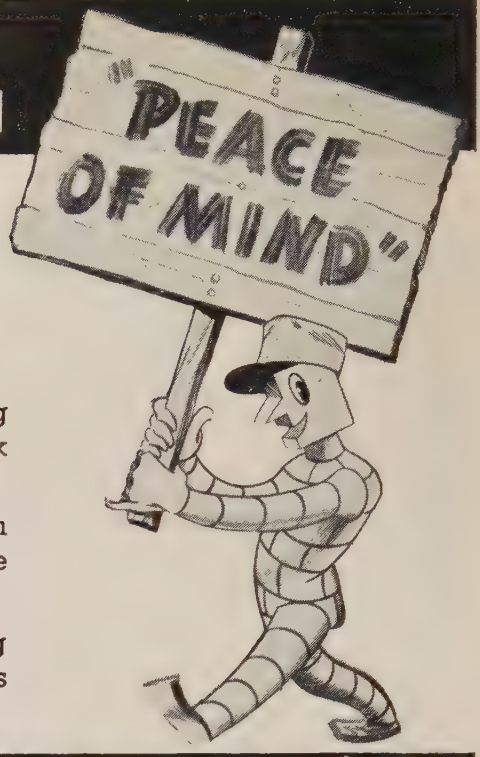

Whether the contract covers one chest or tank lining, or all the corrosion or alkali resistant linings for the entire mill, it is Stebbins responsibility to provide a dependable and satisfactory job that assures continuous operation.

- Sixty-five years experience in designing, installing and servicing linings in pulp and paper mills is back of this contract.
- Thousands of successful installations located on this continent and abroad provide tangible evidence of reliability.
- Think twice before investing in linings—the wrong one can prove very costly—be safe, specify Stebbins—and have no regrets.

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W. Barrett, Sales Engineer in charge of paper mill abrasives for the Carborundum Co., gave a talk on "Pulpstones."

New England

The New England Section held its opening meeting of the season at the Red Lion Inn, Stockbridge, Mass., on Friday, September 30. Following the dinner there was a panel meeting on "Tub Sizing." Ten minute talks were given by each member of the panel as follows: "Enzyme Conversion," by R. A. Gale, Pillsbury Mills, Inc., Minneapolis, Minn.; "Tub Sizing Equipment," by R. B. Holden, Stowe-Woodward, Inc., Newton Upper Falls, Mass.; "Starches," by J. Newton, Clinton Co., Clinton, Iowa, and Robert O. Steffens, Penick & Ford, Ltd., New York, N. Y.; "Practical Mill Problems," by Robert Pattison, Cellulose Fibres, Inc., Holyoke, Mass.

Delaware Valley

The Delaware Valley Section met at Spring Grove, Pa. on October 7, as guests of the P. H. Glatfelter Co. In the afternoon the pulp and paper mill was visited. Following the dinner, E. W. Clem, Chief Engineer of the Rice Barton Co., Worcester, Mass., gave a talk in which he discussed a number of the newer developments on paper machines.

On October 27 the Section will meet at the Engineers Club. A. J. Pingarron of the International Printing Ink Co., will talk on "The End Use as a Factor in Ink Formulation."

On November 30, at the Engineers Club, Simon Collier, Director of Quality Control, Johns-Manville Corp., New York, N. Y., will talk on "Modern Quality Control." A colored sound film illustrating the principles of quality control will be shown.

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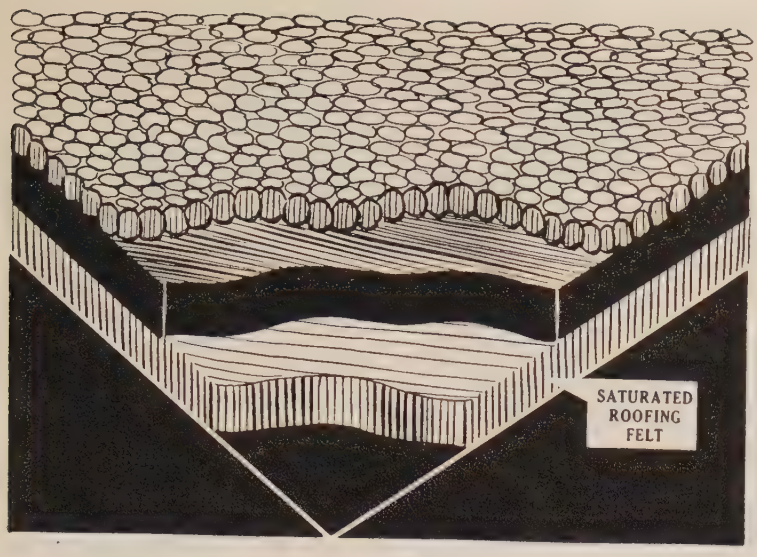

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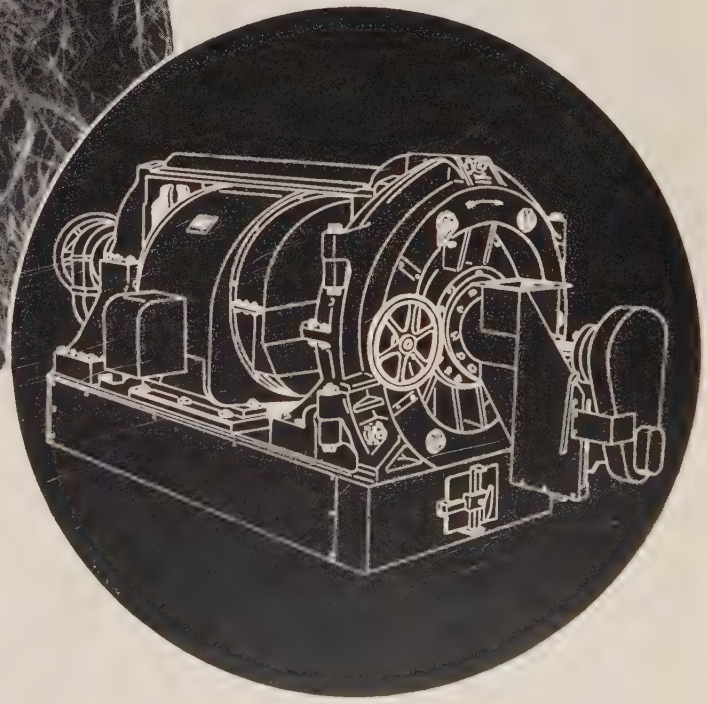

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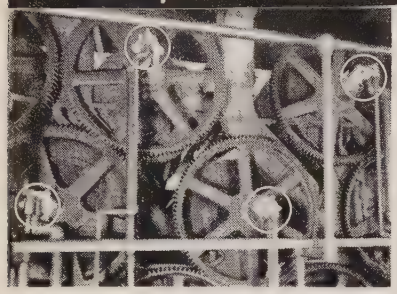

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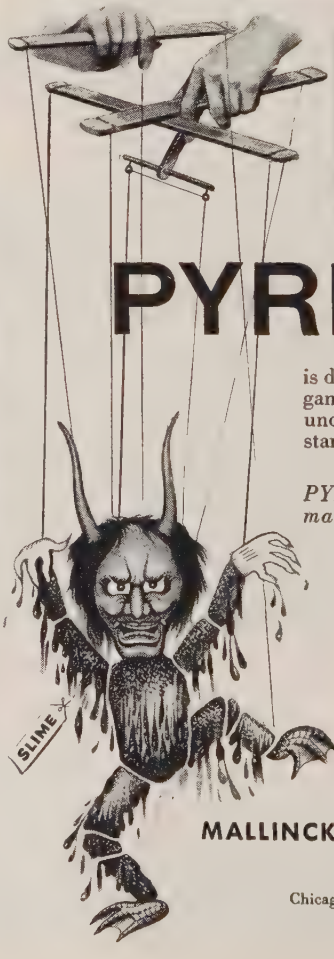
Bulletin No. 1400 describes the S-P-S Tester as well as other Gurley paper testing instruments. It's worth writing for today. W. & L. E. Gurley, Station Plaza & Fulton St., Troy, New York.



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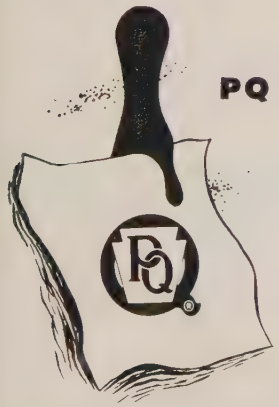

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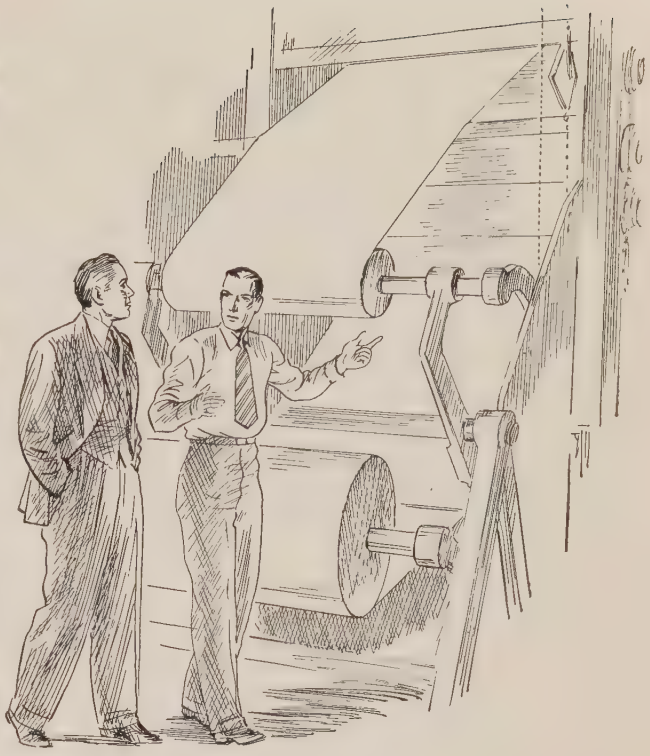

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Calendar of TAPPI Meetings

NATIONAL

Fourth Engineering Conference of the Pulp and Paper Industry, Statler Hotel, Boston, Mass., October 31, November 1–3, 1949.

Fibrous Agricultural Residues Conference, Terre Haute House, Terre Haute, Ind., November 7–8, 1949.

Fundamental Research Conference, Chateau Frontenac, Quebec, P. Q., May 29–30, 1950. Symposium: "The Papermaking Properties of Fibers."

LOCAL SECTIONS

Delaware Valley Section:
October 27, 1949, Engineers Club, Philadelphia, Pa.
November 30, 1949, Engineers Club, Philadelphia, Pa.

Maine–New Hampshire Section: October 21–22, 1949, Lafayette Hotel, Portland, Maine. Panel Discussion on Paper Reinforcers. 2:00 p.m. October 21, 9:00 a.m. October 22.

Pacific Section: October 25, 1949, December 6, 1949.

Empire State Section: Northern Group: November 10, 1949, Woodruff Hotel, Watertown, N. Y.

Ohio Section: November 8, 1949, Dayton, Ohio. Visit to McCall Printing Plant.

Lake Erie Papermakers and Converters Assoc.: November 18, 1949, Hickory Grille, Cleveland, Ohio.

Kalamazoo Valley Section:
November 4 Stock Preparation
December 1 Dyeing.

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